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An Assessment of

Development and Production Potential of Federal Coal Leases

Volume II—Working Papers

Part E:— Vol. I: Development and Production Potential of Undeveloped Federal Coal Leases and Preference Right Lease Applications in the Powder River Basin and Other Wyoming Coal Basins: Wyoming Task Force Report

This is an OTA Working Paper that has neither been reviewed nor approved by the Technology Assessment Board

June 1984

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D. C. 20510

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June 1984

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D. C. 20510

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PREFACE

This report was prepared under contract to the Office of Technology Assessment as part of the study of Federal coal leasing mandated by Section 10 of the Federal Coal Leasing Amendments Act of 1976, Public Law 94-377. OTA used the information and analyses in this report in the preparation of OTA's report, An Assessment of Development and Production Potential of Federal Coal Leases, December 1981. Information in this contractor report is current as of November 1981.

This report consists of two volumes. Volume I contains the results of the OTA Wyoming Task Force, the analysis of the development potential of undeveloped federal coal leases and preference right lease applications in the Powder River Basin of Wyoming and Montana and in other Wyoming coal basins, and a discussion of the need for additional leasing of Federal coal in these regions. Volume II contains the appendices, including detailed summaries of each undeveloped lease block and preference right lease application.

This report was prepared by J.Russell Boulding and Deborah L. Pederson with assistance by James J. Sebesta (Market analysis for Powder River Basin Coal) and by the U.S. Fish and Wildlife Service Western Energy Land Use Team (Rapid Assessment Methodology analysis of coal reserves and potential alluvial valley floors). Additional information and comments were provided by the members of the OTA Wyoming Coal Leasing Task Force. The contract was supervised by Dr. Audrey Buyrn, Program Manager, OTA Materials Progam, and by Dr. Michael Gargas McGrath, Senior Project Associate.

This report is an OTA Working Paper, the opinions and conclusions in this report are those of the authors and do not necessarily represent the views of OTA, the OTA coal leasing project advisory panel, individual members of the OTA Wyoming Task Force, or the Technology Assessment Board. This report has not been reviewed or approved by the Technology Assessment Board.

OTA WORKING PAPER E

VOLUME I

DEVELOPMENT AND PRODUCTION POTENTIAL OF UNDEVELOPED FEDERAL COAL LEASES AND PREFERENCE RIGHT LEASE APPLICATIONS IN THE POWDER RIVER BASIN AND OTHER WYOMING COAL BASINS

WYOMING TASK FORCE REPORT

NOVEMBER 1981

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THE CONGRESS OF THE UNITED STATES
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, D.C. 20510

OTA WORKING PAPER

This report is an OTA Working Paper, which was used in the preparation of OTA's final assessment report. OTA makes these working papers available for the use of those readers desiring a more detailed or technical discussion of a subject than can normally be accomodated in an OTA final report. As an OTA Working Paper, this report has not been reviewed or approved by the Technology Assessment Board. The findings and opinions expressed in this report are those of the authors and do not necessarily represent the views of OTA, the coal leasing project advisory panel, the OTA Wyoming Task Force, or the Technology Assessment Board.

FOREWORD

This report provides an assessment of the development and production prospects for Federal coal leases in the Powder River Basin and southern Wyoming, and summarizes the results of OTA's Coal Leasing Task Force held in Cheyenne, Wyoming, in October, 1980 and additional follow-up by OTA after the Task Force Meeting. The report is one of several state task force reports prepared as part of OTA's evaluation of existing Federal coal leases and preference right lease applications requested under Section 10 of the Federal Coal Leasing Amendments Act of 1976, Public Law 94-377.

A first draft of this report was prepared as a background document for the OTA Wyoming Task Force meeting, and a second draft was completed in November 1980 to incorporate the results of that meeting. The final report has been extensively revised as a result of 1) comments by Wyoming Task Force participants, and 2) by additional follow-up by OTA through contacts with lease holders, and additional analysis done during preparation and writing of OTA's overall report for the coal leases assessment titled An Assessment of the Development Potential and Production Prospects of Federal Coal Leases. Some of the material in earlier drafts of this report has been revised and expanded for incorporation into OTA's assessment report. Rather than incorporate all of this additional analysis in this report, references will be made to pertinent chapters in the OTA assessment report where additional discussion can be found.

The second draft of this report contained a short discussion of the need for new leasing of Federal coal, but several reviewers who participated in the Wyoming Task Force felt that it did not accurately reflect the views expressed at the Task Force meeting. Consequently, discussion of this

issue has been moved to a separate chapter which examines in some detail the reasons for and against new leasing in relation to the results of OTA's analysis of the development potential of Federal leases in the Powder River Basin and southern Wyoming. The conclusions in this final chapter present the views of the author and do not reflect any official position of the Office of Technology Assessment.

Russell Boulding
Environmental Consultant
July 1981

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INTRODUCTION

Compared to the other states covered in the Office of Technology Assessment's study of federal coal leasing, the federal coal reserves in the Powder River Basin of Montana and Wyoming and in other Wyoming coal basins are extensive. Montana and Wyoming together produced 74% of the federal coal mined in 1978. The 102 existing leases in Wyoming represent 18% of all outstanding leases and cover approximately 220,000 acres or 27% of the acreage under lease. Due to the thickness of coal seams in the Powder River Basin, these leases contain about 60% of the recoverable reserves under lease. Preference right lease applications are also significant in Wyoming. The 74 PRLAs in this state represent 42% of the total number on file, cover 34% of the acreage, and include about 60% of the reserves under application. The state of Montana has only 15 leases in the Powder River Basin covering about 31,000 acres; however, Montana ranks as the second largest producer of federal coal in the country.

The 102 federal coal leases in Wyoming form 57 lease blocks (e.g. isolated individual leases or two or more contiguous leases under single ownership) ranging in size from 40 acres to 20,700 acres. Of these 57 lease blocks, OTA has classified 24 as developed--either in production or with approved or soon-to-be approved mine permits--and the remaining 33 blocks as undeveloped. The 74 preference right lease applications in Wyoming form 32 potential mining units, 6 of which are associated with existing or proposed coal mines. The Montana Powder River Basin has 15 federal coal leases that form 8 lease blocks. However, the 3 undeveloped leases in the state cover only 6% of the Montana acreage under lease.

The main focus of this study is on the development and production

potential of the undeveloped federal lease blocks in Wyoming issued before passage of the Federal Coal Leasing Act Amendments of 1976, and 32 PRLA blocks in Wyoming. Five undeveloped lease blocks in the Montana Powder River Basin and central Montana are also covered in this study.* The results of a separate analysis of developed Federal coal leases and selected undeveloped leases (Schmidt, Porte and Silverman, 1980) have been considered in the analysis of undeveloped leases. Production potential from non-Federal coal (state, Indian and private) has also been considered in this study, but non-Federal mines have not been analyzed in detail.

Chapter 1 summarizes criteria used to classify lease blocks as developed or undeveloped, and describes the primary and secondary screens and procedures that were used to evaluate their development and production potential. Chapter 2 discusses the broad legal and legislative issues that may affect production from federal leases in the Powder River Basin and southern Wyoming. Chapters 3 and 4 discuss regional environmental and infrastructure issues affecting lease development, respectively, and Chapter 5 examines market factors that affect the demand for coal from the study area. Chapter 6 summarizes the results of OTA's evaluation of the development and production potential of undeveloped lease blocks and PRLA's in both Montana and Wyoming. This analysis identifies the likely production prospects for undeveloped leases in these states from 1980 to 1991 and examines the significance of these results in relation to implementation of the new federal coal management program.

*The undeveloped federal leases in eastern Montana have been evaluated in OTA's study of leases in North Dakota. Montana also has four preference right lease applications located in the Fort Union region in the eastern part of the state that are not evaluated in this report.

CHAPTER 1. SCREENING CRITERIA AND PROCEDURES FOR EVALUATING THE DEVELOPMENT AND PRODUCTION POTENTIAL OF FEDERAL COAL LEASES

The procedures used by OTA to evaluate undeveloped federal coal leases in the Powder River Basin and the rest of Wyoming involved four basic steps:

1. Organization of leases into blocks of multiple leases using criteria of contiguity and single ownership.

2. Separation of lease blocks into those that are developed and those that are undeveloped.

3. Separation of undeveloped leases into those that have favorable, uncertain, or unfavorable prospects for development based on a set of geotechnical (primary) screens.

4. Separation of those leases in the favorable and uncertain development category into those leases that have favorable, uncertain or unfavorable prospects for production by 1986 and 1991,* based on a set of secondary site specific screens and judgments concerning market conditions and other factors that may affect the regional level of coal development.

This chapter describes the geographic scope of the study, the process of categorizing leases as developed or undeveloped, and the rationale employed in formulating and applying the screening criteria to undeveloped leases.

*1986 and 1991 are related to diligent development requirements for leases issued before passage of the Federal Coal Leasing Act Amendments of 1976. See Chapter 2 for a more detailed discussion of these requirements.

Geographic Scope of the Study

This study covers undeveloped leases and preference right lease applications in the Powder River Basin of northeastern Wyoming and southeastern Montana, and in other Wyoming coal basins. Montana has only a few undeveloped leases in the Powder River Basin. Significant differences in factors affecting lease development in the Montana and Wyoming portions of the Powder River Basin are noted in the analysis of these leases presented in Chapter 6. The undeveloped leases in eastern Montana's Fort Union Region are being evaluated in conjunction with OTA's assessment of the Fort Union Region in North Dakota and, as such, are excluded from this study.

The remaining Wyoming coal basins are grouped together under the heading "southern Wyoming" in the analysis of regional factors affecting lease development. In spite of substantial geological diversity and differences in coal quality characteristics, similarities outweigh differences when these coal basins are compared with the Powder River Basin. All of the undeveloped federal coal leases outside of the Powder River Basin are located in the Green River-Ham's Fork coal region except for two small leases in the Bighorn Basin of northcentral Wyoming.

Figure A.1 in Appendix 1 shows the location of Wyoming coal bearing areas. Maps 1, 2, and 3 following this figure show the location of existing and proposed mines in the Powder River Basin, southcentral and southwestern Wyoming.

Developed and Undeveloped Leases

Many federal coal leases form viable mining tracts only when combined

with other leases. Tables 1.1 and 1.2 list developed and undeveloped lease and PRLA blocks organized according to coal region in Wyoming and Montana respectively. Figures 1.1 and 1.2 show the location of these lease blocks in Wyoming and the Montana Powder River Basin. A more detailed summary of information on these lease blocks can be found in Appendix 1 for Wyoming and in Appendix 4 for Montana. Multiple leases are classified as a single block when they are held by the same owner and form a compact and contiguous unit. Non-contiguous leases that are connected by state and fee coal are considered single blocks, but if two leases are separated by unleased federal coal they are considered separate blocks.* Single leases or PRLAs that are separated into non-contiguous areas by unleased federal coal are classified as single blocks. The fact that they are separated by unleased federal coal was considered to be an unfavorable factor for development potential. Seven preference right lease applications in southern Carbon County that are under single ownership are separated into 6 blocks, even though several are contiguous, because acreage covered by combining the leases would be too large to form mining units appropriate for the underground mining that would be needed to develop these PRLAs.

A lease block is considered developed if it is either presently in production or under construction to start production or if, by the end of 1980, approval of a complete permit application filed with the state and OSM in accordance with the 1977 Surface Mine Control and Reclamation Act (SMCRA) is anticipated. Leases with mine plans on file with the U.S. Geological Survey or the Office of Surface Mining that are incomplete or under active review were considered undeveloped for purposes of this study.

*Where leases or blocks were separated by fee or state coal and available information indicated that the federal leaseholder did not have the right to mine this coal, the amount and location of non-federal coal in the block was considered to be an unfavorable factor affecting the block's development and production potential.

TABLE 1.1 Developed and Undeveloped Federal Lease and PRLA Blocks in Wyoming

	Developed Leases		Undeveloped Leases		PRLAs	
Coal Region	Block Name	Block #	Block Name	Block #	Block Name	Block #
Powder River	Buckskin	9	Armstrong	1	Woodson	P1
	N. Rawhide	10	Bass Trust	2	Thunderbird	P2
	Eagle Butte	11	Gulf (1)	3	Wold-Jenkins (1)	P3
	Wyodak	15	Gulf (2)	4*	Wold-Jenkins (2)	P4
	Caballo	18	Texaco	5	Wold-Jenkins (3)	P5
	Belle Ayre	19	Belco	6*	Wold-Jenkins (4)	P6
	Pronghorn	20	Wildcat	7*	Consol (1)	P7
	Rojo Caballas	21	Blue Diamond	8	Consol (2)	P8
	Cordero	22	Dry Fork	12	Consol (3)	P9
	Coal Creek	23	S. Rawhide	13	Peabody (P1)	P10
	Jacobs Ranch	24	East Gillette Federal	14	Peabody (P2)	P11
	Black Thunder	25	Gulf (3)	16	Wold-Jenkins (5)	P12
	Dave Johnston	32	Peabody (1)	17	Arco (1)	P13
			N. Rochelle	26	Arco (2)	P14
			Rochelle	27	Peabody (P3)	P15
			N. Antelope	28	N. Antelope (1)	P16
			Antelope	29	N. Antelope (2)	P17
			Phillips Creek (1)	30	Peabody (P4)	P18
			Phillips Creek (2)	31	Peabody (P5)	P19
					Western Fuels (1)	P20
					Western Fuels (2)	P21
					Dixie (1)	P22
					Dixie (2)	P23
South Central	Carbon County	33	Hanna South	36	Kemmerer (1)	P24
	Rosebud	34	Cherokee	40	Kemmerer (2)	P25
	Seminoe No. 2	35			Kemmerer (3)	P26
	Vanguard No. 2	37			Kemmerer (4)	P27
	Medicine Bow	38			Kemmerer (5)	P28
	Seminoe No. 1	39			Kemmerer (6)	P29

TABLE 1.1 (continued)

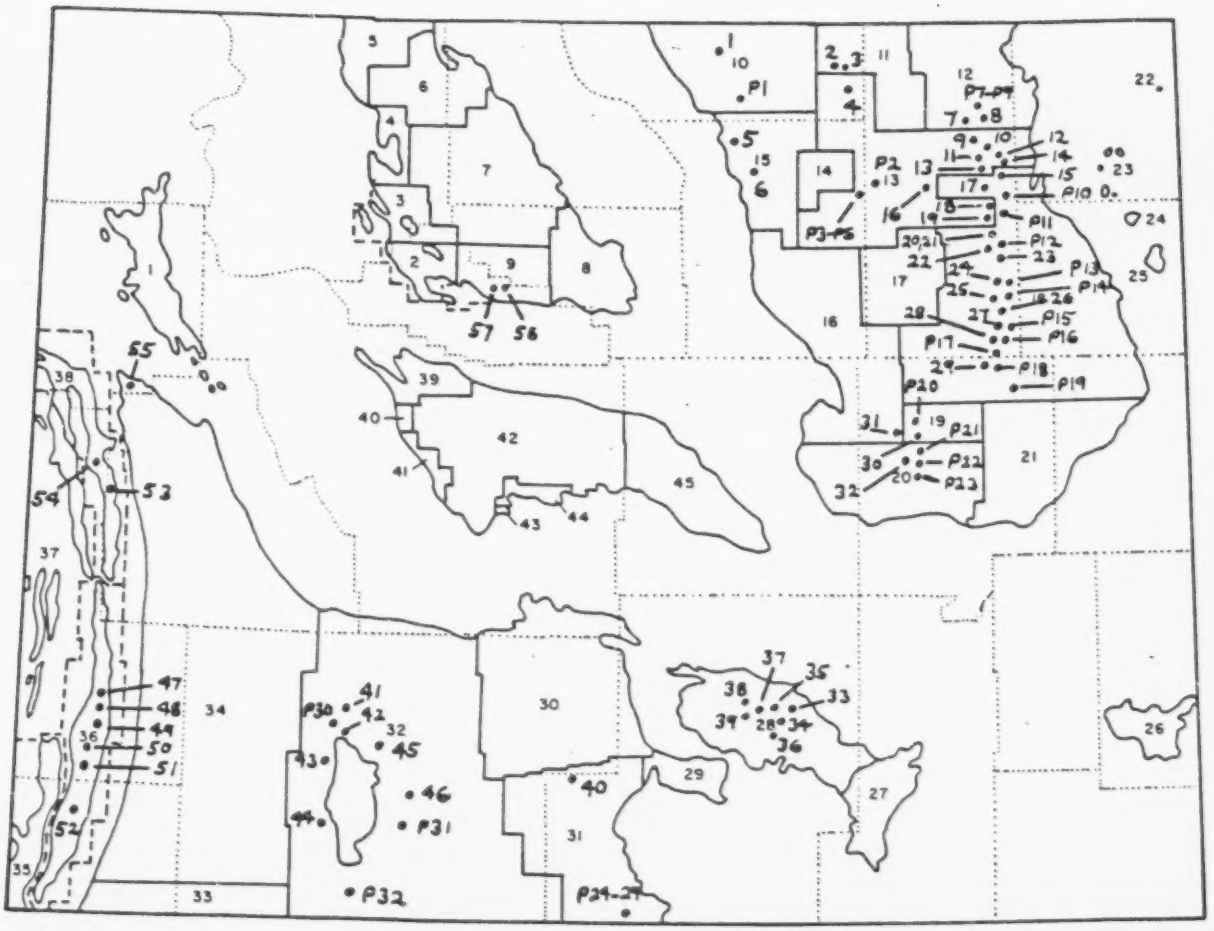
	Developed Leases		Undeveloped Leases		PRLAs	
Coal Region	Block Name	Block #	Block Name	Block #	Block Name	Block #
Southwest	Stansbury	43	Peabody (2)	41	Rosebud	P30
	Jim Bridger	45	Long Canyon	42	Salt Wells	P31
	Black Butte	46	Rainbow	44	Bean Springs	P32
	Elkol Sorenson	50	North-North Block	47		
	Skull Point	51	North Block	48		
			Twin Creek	49		
			South Haystack	52		
			Cottonwood	53		
			Deadman	54		
			Granite Creek	55		
Bighorn Basin	-		Kowlok	56	-	
			Western Nuclear	57		

*Leases containing windows or separated by unleased Federal coal.

TABLE 1.2 Developed and Undeveloped Federal Lease Blocks in Montana (Excluding Fort Union Region)

	Developed Leases		Undeveloped Leases		PRLAs*
Coal Region	Block Name	Block #	Block Name	Block #	
Powder River	Colstrip	1	PKS CX Ranch	6	-
	Big Sky	2	CX Ranch	7	
	Spring Creek	3	Pearl	8	
	East Decker	4			
	West Decker	5			
Bull Mountains	Divide	9	Johnson	10	-
Yellowstone	-		Bugni	11	-

*Montana has two leases and four PRLAs located in the Fort Union Region in eastern Montana which were not analyzed in this study.



No. on map	Coal Field						
1.	Jackson Hole	10.	Sheridan	22.	Aladdin	34.	Labarge Ridge
2.	Grass Creek	11.	Spotted Horse	23.	Sundance	35.	Evanston
3.	Meeteetse	12.	Little Powder River	24.	Skull Creek	36.	Kemmerer
4.	Oregon Basin	13.	Powder River	25.	Cambria	37.	Greys River
5.	Silvertip	14.	Barber	26.	Goshen Hole	38.	McDougal
6.	Garland	15.	Buffalo	27.	Rock Creek	39.	Muddy Creek
7.	Basin	16.	Sussex	28.	Hanna	40.	Pilot Butte
8.	Southeastern	17.	Pumpkin Buttes	29.	Kindt Basin	41.	Hudson
9.	Gebo	18.	Gillette	30.	Great Divide Basin	42.	Beaver Creek
		19.	Dry Cheyenne	31.	Little Snake River	43.	Big Sand Draw
		20.	Glenrock	32.	Rock Springs	44.	Alkali Butte
		21.	Lost Spring	33.	Henry's Fork	45.	Arminto

Figure 1.1 Coal Fields of Wyoming, Showing Location of Federal Lease and PRLA Blocks (See Appendix 1 for More Detailed Map Locations).

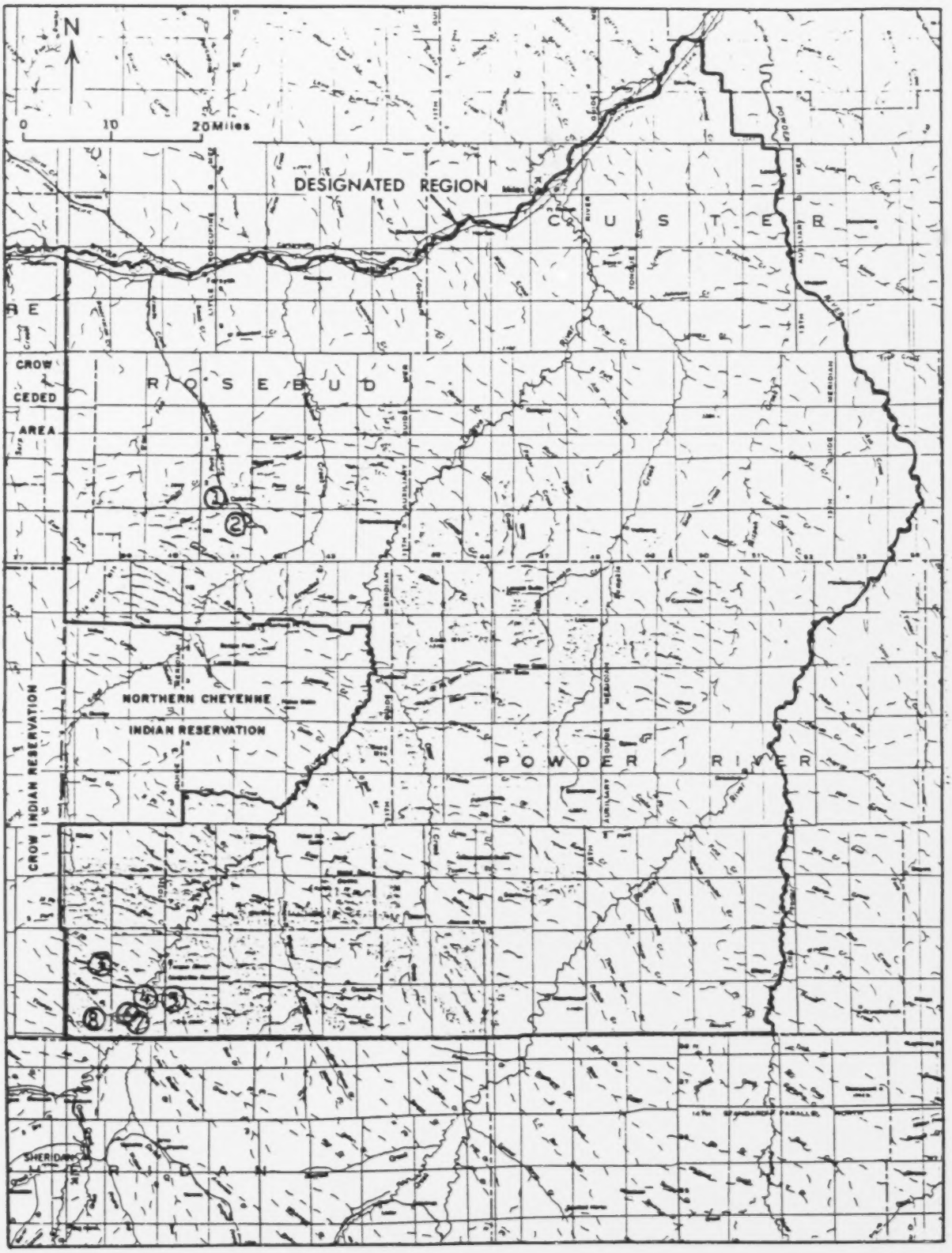


Figure 1.2 Distribution of Strippable Coal Deposits and Location of Federal Lease Blocks in the Montana Powder River Basin (See Appendix 4 for More Detailed Map Locations.

Tables 1.3 and 1.4 summarize the lease block information for Wyoming and Montana. In Wyoming, there are 25 developed lease blocks that include 44 of the 98 federal leases in the state compared to 32 undeveloped blocks that include 54 leases. While slightly less than half of the leases in the state are developed, these leases include more than half (55%) of the acreage under lease. Twenty-one of the 25 developed lease blocks produced coal in 1979. Thirty-four of the 54 lease blocks in Wyoming are located in the Powder River Basin. These blocks cover 29% of the total acreage under federal lease and approximately 30% of the total acreage presently leased in the state. Montana has 11 lease blocks that include 17 leases. Although a little less than half of the lease blocks are undeveloped, they cover only 6% of the acreage under lease. Five of the six developed lease blocks in Montana produced coal in 1979.

Primary Screens for Undeveloped Leases

The first step in evaluating undeveloped lease blocks was to apply a set of primary screens--coal reserves, coal quality and other geotechnical criteria--to determine whether the block has favorable or unfavorable prospects for development. These screens are based on criteria a prudent coal operator would use to determine whether or not a coal property had sufficient value to warrant development efforts during the next ten years. Generally the block must have the following characteristics:

1. The tract must form a viable mining unit (be compact and contiguous).

2. The tract must have sufficient reserves to support a mine.

3. The coal must be of suitable quality for current or potential

TABLE 1.3 - SUMMARY TABLE, WYOMING DEVELOPED AND UNDEVELOPED LEASE BLOCKS BY COAL BASIN

	DEVELOPED LEASES			UNDEVELOPED LEASES		
COAL REGION	Total No. Blocks	Total No. Leases	Total Acres	Total No. Blocks	Total No. Leases	Total Acres
Powder River	13	23	55,411	19	34	77,084
South Central	6	15	23,926	2	5	4,911
Southwest	5	10	31,832	10	13	25,185
Big Horn	—	—	—	2	2	200
TOTAL	24	48	111,169	33	54	107,380

TABLE 1.4 - SUMMARY TABLE, MONTANA DEVELOPED AND UNDEVELOPED LEASE BLOCKS BY COAL BASIN
(Excluding the Fort Union Region)

	DEVELOPED LEASES			UNDEVELOPED LEASES		
COAL REGION	Total No. Lease Blocks	Total No. Leases	Total Acres	Total No. Lease Blocks	Total No. Leases	Total Acres
Powder River	5	12	29,251	3	3	1,739
Bull Mountains	1	1	80	1	1	80
Yellowstone	—	—	—	1	1	80
TOTAL	6	13	29,331	5	5	1,899

markets (heat content not too low, sulfur and ash not too high).

4. The coal seam(s) must be sufficiently thick to be economically mineable and, where surface mines are involved, the stripping ratio must not be too high.

OTA developed preliminary technical screens based on careful review of the characteristics of operating and proposed mines in Wyoming and Montana (Colorado School of Mines 1980, ICF 1980). These screens were initially reviewed with several technical specialists during field interviews in Wyoming in August, 1980. The screens were then refined in a more detailed review of data on existing mines compiled from numerous sources (see Appendix 3) and modified further after discussion and review by the OTA Wyoming Task Force held in Cheyenne, October 14-16, 1980.

Table 1.5 summarizes the primary screens established by OTA for the Powder River Basin and southern Wyoming. The main differences between the criteria for the two regions are that southern Wyoming includes criteria for underground mines, a slightly lower seam thickness criteron, and a slightly higher ash criteron. Two criteria were changed as a result of the Task Force review. OTA's minimum reserve criteria for surface and underground mines in Southern Wyoming (20 and 15 million tons respectively) were raised to 30 million tons and, to take into account Wyoming's more stringent SO_2 emission standards, maximum sulfur content for on-site use of reserves was lowered from 6.0 lbs. sulfur/million Btu to 2.0 lbs sulfur/million Btu.

The screening criteria used in this study reflect a consideration of the possible markets for a coal deposit. Because Wyoming is located far from the main demand centers for coal in the midwest and in the south,

Table 1.5 - SUMMARY OF MINIMUM REQUIREMENTS FOR FAVORABLE LEASE DEVELOPMENT PROSPECTS IN WYOMING (Primary Screens)[1]

End Use	Coal Region	Type Mine	Reserves M Tons	Btu/lb	Sulfur[2] lbs/M Btu	Ash %	Seam Thickness (ft)	Average Overburden (ft)	Stripping Ratio
Steam Coal (export)	Powder River Basin[3]	S	> 30	> 8,000	< .61 (1970 NSPS) < 1.0 (1979 NSPS)	< 10	> 20	< 150	< 2.5
	Southern Wyoming	S	> 30	> 8,500[4]	"	< 12	> 15	-	-
		U	> 30	> 10,000	"	< 12	> 5	-	-
Steam Coal (on-site)	Powder River Basin[3]	S	> 120	< 8,000 acceptable	< 2.0	> 10 acceptable	> 20	< 175	< 3.5
	Southern Wyoming	S	> 120	< "	< 2.0	> "	> 15	-	-
Synthetic Fuels (on-site)	Powder River Basin[3]	S	> 180	< 8,000 acceptable	< 2.0	> 10 acceptable	> 20	< 175	< 3.5
	Southern Wyoming	S	> 180	< "	< 2.0	> "	> 15	-	-

[1] All blocks must be compact and contiguous or form a logical mining unit when combined with intervening state or private coal.

[2] See Table 1.6 for conversion to percentages at different heat contents.

[3] Criteria apply to both Wyoming and Montana portions of the Powder River Basin, except for stripping ratio criteria, which apply only to Wyoming.

[4] Minimum heat content for surface mine-export in southern Wyoming is higher than for the Powder River Basin because more difficult mining conditions create higher mine costs.

economic factors relating primarily to transportation costs dictate more stringent coal quality criteria for these markets. Coal reserves that can be developed onsite or sold locally can be of lower quality than those mined for export. However, minimum reserve criteria are more stringent for coal used for onsite power or synfuel plants because large reserves are necessary to make such plants commercially viable. The rationale for the criteria in Table 1.5 are discussed in more detail below.

Reserve Criteria. In the Powder River Basin a tract must have sufficient recoverable reserves to support a surface mine* with a production capacity of 1 million tons/year of export steam coal for 30 years (30 million tons).** Export reserves in southern Wyoming must be at least 30 million tons for both surface and underground mines. If the tract does not meet export steam coal quality criteria, the reserves must be able to supply a 1000 MW power plant at a rate of 4 million tons/year for 30 years (120 million tons) or a synthetic fuels plant at a rate of 6 million tons/year for 30 years (180 million tons). From an economic standpoint, it would be difficult to support construction of a smaller power or synthetic fuels plant than these reserves would allow. Reserves of 30 million tons are

*No criteria for small mines were established, as was done in several other states, for reasons that are discussed in more detail in Addendum 1 at the end of this chapter.

**OTA assumed, and the Wyoming Task Force agreed that coal deposits in the Powder River Basin that cannot be mined by surface methods will not be developed in the time frame of this study. This assumption eliminates 397 million tons of coal under existing lease and 4.3 billion tons of coal under PRLA that are considered by the Department of Interior to be committed coal reserves (USDI 1979b). In-situ gasification may make development of underground coal in the Powder River Basin feasible, but the commercial development of this technology is not likely to occur before 1991. ARCO Coal Company has formally presented to the Bureau of Land Management an expression of interest in obtaining coal leases suitable for underground coal gasification in the Highlight Review Area, because ARCO does not feel that any reserves on existing leases are suitable for in-situ gasification (letter to OTA from Frederick Scheerer, Exploration Manager, ARCO Coal Company, Denver, Colorado, December 9, 1980). See also discussion of synfuels in Chapter 2.

actually rather marginal for developing a new mine in the Powder River Basin. Most typical new mines will require well over 100 million tons of recoverable reserves (Colorado School of Mines 1980) and one company representative at the Wyoming Task Force stated that a minimum reserve of 150 million tons was necessary to justify opening a new mine. Another company has indicated to BLM that a minimum of 500 million tons of newly leased federal coal reserves would be necessary to compete with existing mines.

The minimum reserves for on-site power plants are based on discussions with the Wyoming Industrial Siting Administration and with Combustion Engineering, a firm that specializes in boiler design. For a synfuels project, 180 million tons of coal is on the low end of minimum reserves needed for such a project. The three synfuels projects currently in active planning stages in Wyoming (Panhandle Eastern, Hampshire and Cherokee) will require a minimum of 5 1/2 to 6 million tons/year. The Panhandle Eastern Project could use as much as 11 million tons/year. See discussion of synfuels in Chapter 2 (National Policy Issues) and Chapter 6 (Development and Production Prospects) for additional discussion of these synfuels projects.

Heat Content. Coal reserves that would be mined and exported for use in power plants in other states must average at least 8,000 Btu/lb for surface mines in all regions and at least 10,000 Btu/lb for underground mines. Transporting surface mined coal with a lower heat content for any significant distance would be economically prohibitive. Minimum heat content for coal mined underground is higher because the capital costs required for underground mine development are higher. Tracts with reserves

sufficient to supply on site facilities can have less than 8,000 Btu/lb because transportation costs are a major consideration.

Sulfur. To a certain extent, the level of acceptable sulfur content for coal is dependent on the plant where the coal is to be burned. For example, the acceptable level of sulfur content for a power plant in a non-attainment area would be lower than for a plant in an area without serious air pollution problems where prevention of significant air quality deterioration is not a factor. Also, new plants will have to meet different sulfur dioxide standards than plants built between 1970 and 1979 which, in turn, have different standards compared to plants built before 1970. Furthermore, the 1979 New Source Performance Standards (NSPS) for sulfur dioxide are quite complex and the impact on western coal resulting from the sliding scale for sulfur removal is not entirely clear.

Sulfur criteria are based on both the 1970 and 1979 NSPS for sulfur dioxide. As with heat content, the sulfur criteria are most stringent for export coal. Coal with less than .63 lbs sulfur/million Btu will meet the 1970 NSPS without scrubbing, assuming a 95% conversion of sulfur to sulfur dioxide which is typical for subbituminous coal (Warholic, et. al. 1980). Compared to the other coals in the study area, this coal potentially has the greatest marketability because it can be sold to existing power plants built between 1970 and 1979 as well as to new power plants. Coal with less than 1.0 lbs of sulfur/million Btu is also considered suitable for export because it can meet the 1979 NSPS with partial scrubbing. The sulfur content of coal used on-site must be less than 2.0 lbs of sulfur/million Btu. Sulfur contents higher than this would require more than 95% sulfur removal to meet Wyoming's sulfur dioxide emission standard of 0.2 lbs SO_2/million Btu.

Table 1.6 shows the relationship between the sulfur criteria and sulfur percentages of different heat contents. The rationale for the export and onsite sulfur criteria are discussed in more detail in Addendum 2 at the end of this chapter.

Ash. Ash is a less critical factor with respect to air pollution requirements because state-of-the-art controls of particulate emissions operate at a very high level of efficiency. However, high ash content increases the cost per Btu of transporting export coal and can create problems in boilers that are not designed for coal with high ash content.

The maximum ash content of coal for export was set at 10% for the Powder River Basin and at 12% for southern Wyoming because of higher heat contents. A survey by ICF, Inc. (1980) found that 90% of 53 operating and proposed mines in the Powder River Basin and southern Wyoming have produced (or would produce) coal with less than 6% ash. Five mines produced coal with 10% to 12% ash. Data in Appendix 3 (Table A.3.3) show that the only mine in the Powder River Basin that produces higher than 10% ash is the Dave Johnston mine which supplies an on-site power plant. Table A.3.4 indicates that several mines in southern Wyoming exported coal with between 10%-12% ash.

Coal with ash levels greater than 12% was considered acceptable for onsite conversion. Boilers can be designed to burn coal with high ash content but disposing of the bottom ash adds additional operating costs and increases the power plant facility requirements. However, factors other than ash content, such as the initial softening temperature of the ash and ash chemistry (silica and sodium content in particular) are more significant for boiler design (personal communication, Russell Holm, Combustion

Table 1.6 - RELATIONSHIP BETWEEN COAL SULFUR CRITERIA AND % SULFUR AT DIFFERENT HEAT CONTENTS[1]

	SULFUR (%)		
Btu/lb	1970 NSPS[2]	1979 NSPS[3] (Partial Scrubbing)	1979 NSPS[4] (Full Scrubbing)
8,000	< .50	< .80	< 1.6
8,500	< .54	< .85	< 1.7
9,000	< .57	< .90	< 1.8
9,500	< .60	< .95	< 1.9
10,000	< .63	< 1.00	< 2.0
10,500	< .66	< 1.05	< 2.1
11,000	< .69	< 1.10	< 2.2

1 Conversion from % sulfur to lbs/$\overline{M}$ Btu can be done using the equation

$$\text{lbs S}/\overline{M}\text{ Btu} = \% \text{ Sulfur } \left(\frac{1{,}000{,}000}{\text{heat content of coal (lb/Btu)}}\right)$$

2 .63 lb S/$\overline{M}$ Btu = 1.2 lbs $SO_2/\overline{M}$ Btu assuming 95% conversion of sulfur to sulfur dioxide

3 1.0 lb S/$\overline{M}$ Btu = 0.6 lb $SO_2/\overline{M}$ Btu with 70% sulfur reduction

4 2.0 lb S/$\overline{M}$ Btu = 0.2 lb $SO_2/\overline{M}$ Btu with 95% sulfur reduction (Wyoming standard)

Engineering, Inc., San Francisco, California). Because data on ash chemistry was not available on a block specific basis, no upper ash percentage limit was set for onsite conversion.

Seam Thickness and Dip. The 20 foot minimum for seam thickness in the Powder River Basin was chosen after discussions with geologists at Federal and state agencies. Seam thickness at existing mines in the Powder River Basin ranges from 35 to 110 feet (see Appendix A.3.3). Therefore, a typical new mine operation in this region would probably require seam thickness greater than the minimum criterion of 20 feet to be able to compete with existing mines. The heat content of the coal is higher in southern Wyoming, where the minimum seam thickness was set lower at 15 feet. A minimum seam thickness of 5 feet was set for underground mines in the region. Multiple seam surface mining is common in southern Wyoming and combined seam thicknessess typically range from 20 to 300 feet. Thickness of underground seams in existing mines ranges from 6 to 19 feet (see Table A.3.4, Appendix 3). If there is more than one seam near the surface, and topography and interburden thickness allow multiple seam mining, the thickness criterion is applied to the total thickness of mineable seams.

Seams in the Powder River Basin are relatively flat-lying so seam dip is not a factor that adversely affects mining. However, seam dip can be a constraint on mining in southern Wyoming where coal seams dip 90 degrees. The maximum dip for existing surface mines in the region is 25°; for underground mines the maximum dip is 13°. A seam dip greater than 15° for underground mines was considered to have an adverse affect on lease development potential because dips more than 15° cause resource recovery difficulties.

Overburden Thickness and Stripping Ratio. Maximum overburden thickness and stripping ratios (the ratio of cubic yards of overburden per ton of coal removed) were established for leases in the Powder River Basin, but not in southern Wyoming. Average overburden thickness for most mines that currently export coal is usually less than 130 feet, and the maximum stripping ratio for mines is 2.3 (see Table A.3.3, Appendix 3). The criteria for export coal in the Powder River Basin were set conservatively at a maximum average depth of 150 feet overburden and a stripping ratio of 2.5. Maximum averages of 175 feet for overburden and 3.5 for stripping ratio are deemed acceptable in cases where coal could be used onsite because reduced transportation costs would justify higher stripping ratios. For example, the Dave Johnston Mine, which supplies the nearby Dave Johnston Power Plant, has a stripping ratio of 3.3 compared to the high of 2.3 for mines that export coal.

Secondary Screens for Undeveloped Leases

A second set of criteria were developed to evaluate the potential for production by 1986 and 1991 for those leases that had favorable or uncertain development prospects based on application of the primary geotechnical screens.* These screens are much less precise than the primary screens and include factors that could affect the likelihood of production either positively or negatively within the next ten years. The questions used in applying these secondary screens, and the ratings for development they generated, are presented in Appendix 2.

*Note that failure to pass all the primary screens did not automatically give a block unfavorable development prospects. See discussion of the use of screens to evaluate development and production potential in Appendix 2.

Factors that count against favorable prospects for production include:

1. Lack of coal mining experience and financial capability to develop the lease.

2. Lack of evidence of significant exploration development work or baseline environmental studies at the site.

3. Distant location from existing or proposed rail lines.

4. Presence of geologic, geographic or engineering conditions that would make mining difficult.

5. Known environmental problems at the site.

6. Known legal or institutional problems at the site.

Additional factors affecting the production prospects of preference right lease applications include:

1. The existence of areas covered by claims under the 1872 Mining Law, and

2. Evidence that procedural requirements for the issuance of the original prospecting permit or demonstration of commercial quantities of mineable coal have not been properly followed.

These factors are discussed in more detail in Chapter 2.

PRLAs that did not meet the reserves criteria, but were associated with an existing developed or undeveloped lease with favorable development prospects, were considered to have favorable development prospects if they passed the other screens.

Broader Issues Affecting Lease Development

The likelihood that any given lease block will be developed is contingent on many factors. The level of development in a region is affected by both the availability of reserves for production and the market demand for coal from the region. If market demand is lower than the production capacity of existing mines then development of undeveloped leases will depend largely on a leaseholder's ability to sell coal at a price below that of coal already being mined. Equally important, however, are the threshholds beyond which coal production may exceed the capacity of the socioeconomic infrastructure to accommodate further growth, and environmental considerations may restrict either the availability of certain reserves or the pace of development. Where production to meet market demand exceeds these threshholds, then the level of actual production will be affected more by threshhold considerations than by market considerations. National and regional coal policy issues, regional environmental and infrastructure threshholds and market issues affecting lease development are examined in more detail in the following four chapters.

ADDENDUM 1. Small Mines in Wyoming

In several states with federal coal leases, OTA has developed special criteria for small mines that supply coal to local markets and thus do not meet the reserve criteria for mines that export coal from the state or are used onsite. Such criteria were not developed for this study because, although there are several small mines currently operating both in the Powder River Basin and in southern Wyoming, the history of such operations indicates that small mines on federal leases would probably not be able to meet the continuous production requirements for diligence.

During the past decade in Wyoming few mines producing less than 100,000 tons/year have stayed in production continuously for more than three or four years (personal communication, Gary Glass, Wyoming Geological Survey). The Welch mine in Sheridan County and the East Antelope Mine in Converse County are examples of small mines that shut down in the Powder River Basin after 1976. The Ronocco mine in Hot Springs County and the Rainbow No. 8 mine in Sweetwater County are examples of small mines in southern Wyoming that have shut down in the last three years.* In 1979, several mines in southern Wyoming (Carbon County, Vanguard No. 2 and Stansbury) produced less than 1 million tons, which the OTA Wyoming Task Force considered to be a minimum for new mines, but in each case production was far below the design capacity of the mine.

Some of the reasons for the general absence of small mines in Wyoming include: 1) competitive disadvantages to small operators in obtaining access to transportation (in the Powder River Basin particularly); 2) presence of

*Since the November draft of this report was completed, two other small mines have shut down: Stansbury in Sweetwater County and Black Mountain in Sheridan County.

difficult mining conditions or lack of access to transportation networks in the higher quality deposits in southern Wyoming; and 3) relatively limited home heating markets.

The decision not to develop small mine criteria for this study also appears justified by an examination of the several small federal leases involving underground coal reserves in Wyoming. There is no evidence of efforts to develop the two small leases in the Bighorn Basin. The Granite Creek lease in Teton County is in the process of being relinquished, and recent efforts to open the Cottonwood mine in Sublette County were deterred because permitting requirements under SMCRA proved to be too complex and costly considering the small reserves involved and distance from transportation networks (see Cottonwood undeveloped lease block summary sheets, Appendix 2). It is possible that conditions more favorable for small mine operations may develop in the future but it is unlikely that the situation will change dramatically before 1986, and leases suitable for small mine development are not likely to qualify for extensions to the diligence deadline (see discussion of diligence in Chapter 2).

ADDENDUM 2. Coal Sulfur Content and Sulfur Dioxide Emission Standards

The 1979 New Source Performance Standards for sulfur dioxide establish a dual standard for sulfur reduction based on sulfur content and maximum allowable emissions of sulfur dioxide. If 70% sulfur reduction will result in an emission rate of less than .6 lbs sulfur dioxide/million Btu, complete sulfur reduction will not be necessary. Other coal must have 90% reduction in sulfur, but cannot emit more than 1.2 lbs sulfur dioxide/million Btu. For high sulfur coal, this translates into a maximum of 6.0 lbs sulfur/million Btu (90% reduction of this amount equals 1.2 lbs sulfur

dioxide/million Btu). For low sulfur coal, this translates into a maximum of 1.0 lbs sulfur/million Btu (70% reduction of this amount equals 0.6 lbs sulfur dioxide/million Btu).

Wyoming coal that is exported with more than 1.0 lbs sulfur/million Btu would have to have 90% sulfur reduction rather than 70%. Typically, Wyoming coal needing 90% sulfur reduction will have difficulty competing in export markets with local coal. Low sulfur coal tends to be easier to scrub than high sulfur coal, but this advantage may be offset by allowances in the present regulations that give credit for sulfur reduction by cleaning. According to studies by the U.S. Bureau of Mines, mechanical cleaning of coal from Northern Appalachia and the Midwest can result in average reductions in sulfur of about 33% and 23% respectively (Deurbrouck 1972). This means that sulfur reduction by stack scrubbing would typically need to range from 57% to 67% for eastern coal compared to 70% for low sulfur-low Btu coal.

Most of the sulfur in Wyoming coals tends to be in organic forms that are not amenable to reduction by mechanical cleaning. Consequently, most sulfur reduction of Wyoming coal will have to occur at the plant. It appears, then, that the amount of scrubbing at power plants will generally be the same in the midwest and in the south whether Wyoming or high sulfur local coals are used. The added transportation cost of Wyoming coal would probably offset any cost advantage in these markets resulting from the greater ease of scrubbing, except where total emissions must be minimized, in which case partial or full scrubbing of Wyoming coal will result in lower total emission than full scrubbing of local higher sulfur coal. In any event, since there is a ready supply of coal in the region with less than

1.0 lbs sulfur/million Btu, it doesn't appear that coal with higher sulfur content will find ready markets.

Six lbs sulfur/million Btu is the maximum allowable sulfur content that can meet the national NSPS of 1.2 lbs sulfur dioxide/million Btu with 90% reduction. However, Wyoming's standard is lower (0.2 lb sulfur dioxide/million Btu) so sulfur criteria for onsite conversion were based on this more stringent standard. With 90% sulfur reduction (which is the typical state-of-the-art) this would translate into the same sulfur content as the partial scrubbing standard (1.0 lbs sulfur/million Btu). However, it was assumed that 95% sulfur reduction could probably be achieved for onsite conversion possibly with a combination of coal cleaning (not currently practiced in the region) and flue gas desulfurization.* This translates into a maximum sulfur content of 2.0 lbs sulfur/million Btu. The significance of the Wyoming sulfur dioxide standard for lease development is discussed in more detail in Chapter 3.

*While sulfur reduction by mechanical cleaning is limited by the high proportion of organic sulfur in Wyoming coal, some reduction is possible and might well be justified at a mine mouth power plant.

CHAPTER 2. NATIONAL POLICY ISSUES AFFECTING LEASE DEVELOPMENT

The development of a lease block must take place in the context of a complex set of laws and administrative procedures. Existing laws, such as the Federal Land Policy and Management Act of 1976 and the Surface Mining Control and Reclamation Act of 1977, place certain constraints on the development of existing federal coal leases. Proposed laws, such as slurry pipeline and severence tax legislation, or litigation over existing laws may change the climate for coal lease development either favorably or unfavorably.

This chapter summarizes some of the key legal and legislative issues that can affect lease development in the Powder River Basin and in southern Wyoming. These issues can affect the development and production prospects of a specific lease block in two distinct ways. First, certain elements of national environmental policy, such as the alluvial valley floor provisions in SMCRA, can limit the availability of reserves under existing lease. Second, other national policies, such as sulfur emission standards or transportation regulations, can change the competitive position of coal mined in this region in relation to coal mined in other regions.

Issues Affecting the Availability of Reserves for Development

Approximately 10 billion tons of recoverable surface reserves and 1 billion tons of recoverable underground reserves are under existing federal leases in the Powder River Basin and in southern Wyoming. An additional 1.6 billion tons of surface reserves are included in preference right least applications. A major impediment to the establishment of a rational federal coal leasing policy stems from uncertainties concerning how much of these

reserves are, in fact, available for production. Not all reserves under existing federal lease will be mined. The extent to which coal reserves under lease are mined will depend, in large part, on the implementation of national policy in several areas: 1) enforcement of diligent development requirements may result in cancellation or relinquishment of existing leases of marginal or low economic value; 2) non-issuance of pending preference right lease applications will reduce reserves; 3) enforcement of environmental laws, SMCRA in particular, and other situations, such as urban development over coal reserves, may prevent the mining of part or even all of a lease. Offsetting these potential reductions in reserves under existing lease is the possibility that some leased federal coal reserves that cannot be mined for some of the reasons mentioned above, will be exchanged for unleased federal coal. Some non-federal (Indian and private) coal is also subject to exchange for unleased federal coal.

Diligent Development.* The granting of a mineral lease stipulating that the lease be developed with due diligence is a longstanding practice in the private sector. The 1920 Mineral Leasing Act specifies that the terms of a lease be indeterminate, subject to the conditions of due diligence and continued operations. The Department of Interior never defined a specific meaning for diligent development of federal coal leases until shortly before passage of the 1976 Federal Coal Leasing Amendments Act (FCLAA). The promulgation of diligence regulations before the 1976 FCLAA has lead to a complex situation where leases issued before August 4, 1976 are covered by a slightly different set of diligence requirements than leases issued after that date.

*Requirements for and uncertainties surrounding enforcement of diligence are examined in detail in Chapter 8, Office of Technology Assessment, An Assessment of the Development Potential and Production Prospects of Federal Coal Leases (Washington, D.C.: OTA, 1981).

The effect of due diligence requirements on pre-FCLAA leases may involve not only the pre-FCLAA diligence regulations but also post-FCLAA regulations and attempts to implement the concepts of logical mining unit, maximum economic recovery and fair market value. Industry has argued that the 1976 due diligence regulations cannot be applied legally to existing leases. The only recent litigation that might have clarified the legality of the regulations, a suit by Mobil Oil concerning the Rojo Caballos lease, was settled out of court so this legal question remains unresolved. Implementing these concepts in the administration of existing leases can have an important bearing on the leasing of new federal coal.

It is not possible to draw firm conclusions concerning how diligence requirements will affect the development of existing leases because the pertinent regulations and administrative policies are still not firmly set. Stringent enforcement of diligence and maximum economic recovery could result in cancellation or relinquishment of significant reserves of coal (on the order of hundreds of millions of tons); liberal extensions of the 1986 diligence deadline and conservative application of requirements for maximum economic recovery would probably not change development prospects for leases of low economic value, and enforcement of diligence regulations would probably still result in cancellation of large acreages under existing lease. However, these acreages would involve relatively small amounts of coal reserves. The possible effects of due diligence requirements on undeveloped leases in the Powder River Basin and southern Wyoming are discussed in more detail in Chapter 6 in this report as part of the analysis of the development and production potential of undeveloped leases, and also in Chapter 6, OTA (1981).

Preference Right Lease Applications.* The Mineral Leasing Act of 1920 gave the Secretary of Interior authority to grant prospecting permits where "prospecting or exploratory work is necessary to determine the existence or workability of coal deposits in any unclaimed, undeveloped area". A holder of a prospecting permit who demonstrated the presence of commercial quantities of coal was then entitled to a preferential, noncompetitive lease to the coal resources discovered on the property. The 1976 Coal Leasing Amendments eliminated this system, but the legacy of federal coal tied up under PRLAs remains a complication in the development of a rational federal coal leasing policy.

Approximately 1.6 billion tons of reserves are contained in 74 preference right lease applications (PRLA) covering about 140,000 acres in the Powder River Basin and southern Wyoming.** If all these PRLAs were granted and put into production by 1994***, production over and above that from existing leases could be considerable. However, several factors may prevent many of these PRLAs from being issued as leases.

1. Procedural requirements. BLM regulations covering propsecting permits (43 CFR 3511.4-2) specified that failure to comply with either the procedural or financial duties imposed on permittees

*More extensive discussion of PRLAs can be found in Chapter 8, OTA (1981).

**The 4.3 billion tons of underground reserves in the Powder River Basin identified in ACLDS are not considered reserves in this study for reasons discussed in the previous chapter.

***Current regulations require that all PRLAs be processed by 1984; consequently, the latest PRLA could begin production and meet diligence requirements in 1994.

would result in termination of the prospecting permit. One important procedural requirement was that the permittee had to make an initial showing of commercial quantities of coal before the term of the permit expired. At least seven PRLAs in Wyoming either have no reserves at all or no commercial quantities that have been demonstrated.

2. Previous Claims. The Mineral Leasing Act allowed the issuance of a prospecting permit only for those lands which are "unclaimed and undeveloped". According to the Department of Interior's Solicitor's Opinion M-36893 (August 1, 1977) PRLAs cannot be issued on land covered by previously issued mineral claims under the 1872 Mining Law. At least 14 of the 74 PRLAs in Wyoming covering 25,865 acres are covered by one or more mining claims. A PRLA can be rejected if a mining claim covers such a large percentage of the lease as to preclude efficient mining. The Department of Interior is presently reconsidering the Solicitor's opinion in this matter.

3. The Existence and Workability of Coal Deposits. Prospecting permits were to be issued only where the existence and workability of coal deposits was unknown. The concept of workability is not equivalent to the economic viability (i.e. commercial quantities) of a proposed operation (Thatcher 1979). At least nine PRLAs in Wyoming are subject to challenge because the prospecting permit contained abandoned underground mine workings, or included coal seams shown on geologic maps published by the U.S. Geological

Survey before the prospecting permit was issued. The Department of Interior has not established any policy covering PRLAs where existence and workability of coal reserves was known before issuance of the prospecting permit, but it may have the discretionary authority to reject PRLAs on these grounds.

4. Final Determination of Commercial Quantities. Final determination of commercial quantities of coal on PRLAs will be based on more stringent standards than initial showing on prospecting permits. Factors that might affect such final determination could include environmental unsuitability, consistency with land use plans, coal quality, sufficiency of reserves and likely markets (U.S. Department of Interior 1978c). Two-thirds of the PRLA blocks in Wyoming were judged by the Wyoming Task Force to have unfavorable prospects for development and could possibly be rejected.

The importance of these and other factors affecting the development potential of PRLAs in Wyoming are examined in more detail in Chapter 6.

Environmental Requirements. Environmental laws governing coal mining can have two effects on coal reserves. Under certain circumstances, mining may be prohibited completely, as in the case of agriculturally important alluvial valley floors or alluvial valley floors where the essential hydrologic function cannot be restored. In other situations, particularly where reserves have marginal economic value, added costs due to compliance with reclamation and other laws may render the property uneconomical. These environmental issues are discussed in more detail in the next chapter. It will suffice to note here that requirements relating to alluvial valley floors appear to be the only environmental restriction that could reduce the

availability of substantial amounts of leased federal coal reserves. Such amounts would be small, however, when compared to total reserves under lease. Fugitive dust problems may restrict the timing of reserve development, but probably not the ultimate prospects for development.

Exchange.* The exchange of leased federal or non-federal coal reserves that cannot be mined under existing laws for unleased federal reserves could offset reductions in the availability of reserves discussed above. If large amounts of reserves under existing lease qualify for exchange, this could reduce the availability of federal coal to new companies. Consequently, this issue is of particular importance with respect to the timing and form of new federal coal leasing.

Congress has not given the Department of Interior generic authority to exchange leased reserves that cannot, or should not be mined so, at the present time, exchange is limited to certain situations specified by statute:

1. Section 510(b)(5) of SMCRA requires that reserves under agriculturally important alluvial valley floors prevented from mining must be exchanged if substantial financial and legal commitments were made by the leaseholder prior to January 1, 1977.

2. P.L. 95-554 passed in 1978 authorizes exchange of reserves on 9 leases in 6 lease blocks in northeastern Wyoming that would be prevented because of right-of-ways along Interstate 90.

*An expanded discussion of exchange, along with analysis of the amount of reserves that might be affected by exchange can be found in Chapter 8 (OTA, 1981).

3. P.L. 96-401, passed in 1980, authorizes exchange of 6 leases and 3 permits held by Peabody Coal Company on the Northern Cheyenne Indian Reservation in Montana for unleased Federal coal. The tribe has been trying since 1973 to cancel these leases and permits, which contain an estimated one billion tons of coal. In exchange for cancellation, Peabody Coal Company will be issued a noncompetitive lease for lands containing up to 130 million tons of recoverable Federal coal.

It is difficult to predict how much coal under alluvial valley floors will be exchanged. The Decker Mine in Montana and the Bighorn Mine in Sheridan County, Wyoming could involve such exchanges. Several other mine proposals involving non-federal coal, such as the Montco Mine in Montana and the Whitney Mine in Sheridan County, include substantial amounts of reserves under agriculturally important alluvial valley floors. The Office of Surface Mining has adopted a narrow definition of substantial financial and legal commitments (30 CFR 762.5) so it is uncertain that these mines would qualify for exchange.

Exchange under P.L. 95-554 includes parts of the existing Wyodak Mine and three lease blocks with favorable development prospects--Lake DeSmet, East Gillette Federal and South Rawhide. The Secretary of Interior has already decided not to exchange reserves on the Lake DeSmet lease. The Wyoming Task Force judged the three other leases authorized for exchange--Armstrong, Gulf (3) and Belco--as having unfavorable development prospects.

Since leases with unfavorable development prospects have little economic value and are unlikely to meet diligence requirements, they might

not be exchanged. On the other hand, administrative discretion could be exercised to exchange these leases for other more favorable reserves elsewhere. Gulf Oil Company has requested that the Gulf (3) lease be exchanged for unleased federal coal separating its Wildcat lease. Very large reserves, possibly more than a billion tons, will be involved in the exchange of leases on the Northern Cheyenne Reservation.

Other exchanges being actively explored that are not specifically authorized by statute would be contingent upon specific Congressional authorization. The Council of Energy Resource Tribes (1980) recommended that the legislation concerning control of surface mining on Indian lands include provisions for compensation for reserves that cannot be mined under alluvial valley floors. The Northern Cheyenne and the Crow in Montana have large reserves under alluvial valley floors. In southern Wyoming, where federal coal is checkerboarded with non-federal coal, environmental restrictions on mining will have similar affects on both non-federal coal and federal coal. Some consideration has been given to the possibility of exchanging checkerboarded railroad coal in areas undesirable for mining for unleased federal coal in areas suitable for mining. Specifically, there has been a proposal to exchange unleased federal coal reserves on the east slope of the Haystack Mountains northeast of Rawlins for checkerboarded coal at the Atlantic Rim where a critical winter range for several big game species is located. Such an exchange would also require specific congressional authorization and is quite different in nature from exchanges discussed previously, which only involve exchange of lease rights. In this proposed exchange, ownership of the coal would change hands and result in the formation of a single block of federal coal in an environmentally sensitive area that would not be developed and another single block of private coal

that would be mined.

The Department of Interior's limited experience with trying to implement these kinds of exchanges has revealed the technical and administrative difficulties involved in working out an exchange agreement acceptable to both parties. However, lease holders with reserves that cannot be mined because of environmental constraints can be expected to press for exchanges through litigation and other channels. Hence, even if significant reserves are made unavailable because of environmental restrictions, the amount of leased federal coal reserves may remain relatively unchanged. If this occurs, presently leased federal and non-federal coal may not be developed, but other unleased federal coal could be exchanged for development instead.

Issues Affecting the Market for Available Federal Reserves

The previous discussion has focused on issues affecting the availability of reserves for mining. This section briefly examines existing or proposed federal laws that affect the demand for coal from existing federal leases.* There are six major issues that could affect the demand for coal from existing federal leases: 1) sulfur dioxide emission controls, 2) slurry pipeline and rail deregulation legislation, 3) synfuels legislation, 4) severence tax legislation, 5) federal pricing policies for federal coal and 6) federal surface mine regulations.**

*The effect of these issues on the demand for coal in the Powder River Basin and southern Wyoming are discussed in more detail under regional market issues in Chapter 5.

**Oil back-out legislation passed by the federal government requiring substitution of oil for coal in certain existing power plants has a relatively small effect on markets for western coal, because most plants involved in oil back-out are on the east coast and will use eastern coal.

Sulfur Dioxide Standards. One important requirement in the Clean Air Act Amendments of 1977 has adversely affected the demand for western coal--the requirement that sulfur dioxide emissions must be reduced regardless of the sulfur content of the coal. At present, EPA regulations require the partial scrubbing of low sulfur coal and full scrubbing of high sulfur coal. How this requirement will affect the development of western coal remains unclear. But, the discussion of coal sulfur quality in the previous chapter indicates that some additional coal reserves that were not in compliance with the 1970 NSPS could be used with only partial scrubbing. In general, the savings that would accrue from partial scrubbing of western coal would not offset the high transportation costs to eastern markets, so the potential markets for coal from the Powder River Basin are still considerably fewer compared to market prospects before implementation of the 1979 NSPS.

Slurry Pipelines and Rail Deregulation. Because Wyoming coal is located far from the major energy demand centers of the United States, transportation costs are a critical factor in its competitive position with the coal that is mined nearer to these demand centers. The cost of moving Powder River coal by train may comprise two-thirds to three-quarters of the delivered price of the coal. Slurry pipelines have the potential for improving the competitive position of Wyoming coal by reducing transportation costs.* On the other hand, slurry pipelines only help those

*An OTA study titled A Technology Assessment of Coal Slurry Pipelines: Summary (Washington, D.C.: Office of Technology Assessment, September 1980) identified 12 economic conditions that tend to favor coal slurry pipelines over other transportation modes on any particular route. With the exception of uncertainties over availability of water, most of these favorable conditions exist in the Powder River Basin. See also discussion of coal slurry pipelines in Chapter 4 (Regional Infrastructure Issues) and Chapter 7 (Transportation) in OTA (1981).

producers and users who are served by them. Pipelines could adversely affect those who must still rely on rail transportation if the railroads increased their rates to maintain current profit margins. Legislation giving slurry pipelines eminent domain may lessen the difficulties involved in obtaining the right-of-way to lay pipelines, particularly across railroad right-of-ways. If such legislation does pass, the commercial development of slurry pipelines could occur sooner than is now anticipated, thus increasing the competitive position of Wyoming coal in some export markets. Passage of slurry pipeline legislation has been stalled for two main reasons: 1) slurry companies want eminent domain over private land as well as over railroads and 2) western states want protection of water rights and restrictions on slurry water use.

There is a general consensus that rail transportation costs over the next ten years are likely to increase at a faster rate than inflation.* Coal slurry pipelines may reduce transportation costs between certain points, but there is no consensus as to how significant these cost savings may be, nor is there much certainty as to the magnitude of real increases

*Participants in a conference held in October 1980, shortly after the Staggers Rail Act of 1980 was signed into law reached the general conclusion that there would be an almost immediate impact in terms of increased rates for shipping coal (Coal Week, October 20, 1980). The Department of Energy assumed a 15% real increase in rail transportation costs between 1978 and 1985 in setting its preliminary regional coal production goals. However, ICF has found that between 1978 and 1980 alone real increases (i.e. adjusted to account for inflation) were 10.5%, almost as much as DOE's projected increase over the seven year period. This underestimation of likely rail increases resulted in a considerable overestimation of demand for coal from the Powder River Basin (ICF Analysis and Critique of the Department of Energy's August 7, 1980 Report Entitled "Preliminary National and Regional Coal Production Goals for 1985, 1990 and 1995." (Washington, D.C.: ICF, Inc. October 1980). Rocky Mountain Energy Company projects a 40% real increase in rail transportation costs in southern Wyoming between 1980 and 1990 (personal communication, Stephen Berg-Hansen, OTA Wyoming Task Force, October 16, 1980).

that can be expected in rail transportation costs. However, the net effect of real increases in transportation costs will adversely affect the competitive position of western coal with respect to midwestern coal because longer distances are involved.

Synfuels Legislation. At present, on a Btu basis the price of a barrel of oil on the world market is equivalent to three or four times the price of a ton of coal. However, the estimated marginal costs of gas and oil extracted from coal still exceed current prices of oil and gas. For this reason, the extensive commercial development of coal-based synthetic fuels over the next decade is likely to depend on incentives from the federal government in the form of subsidies or risk sharing. Some incentives are currently provided in the form of grants from the Department of Energy to fund feasibility studies of synfuel projects. If federal loan and purchase guarantees are forthcoming for coal-based synfuels development, this might well lead to a significant new demand for coal in the Powder River Basin and southern Wyoming, where feasibility studies for three synfuels projects are currently underway.

Two proposed synfuel plants in the Powder River Basin have received funds from DOE for feasibility studies: Panhandle Eastern and the Hampshire Project (a joint venture by Kaneb Services, Northwest Life Assurance, Allis Chalmers and Koppers). Coal from Peabody's Rochelle lease is already committed to Panhandle Eastern's proposed gasification plant. Another project proposed in Southern Wyoming, the Cherokee Clean Fuels Project, is a joint venture involving Pacific Gas and Electric, Southern California Edison, and Betchel that would use coal from NERCO's Cherokee lease in Carbon County. At present, however, this study is not funded by DOE.

All currently proposed large-scale synthetic fuels projects in the Powder River Basin are for surface conversion of coal to gas or liquids. Another potential way to obtain gas from coal is through in-situ gasification of deep coal seams that cannot be mined by surface mining methods. The thick coal seams in the Powder River Basin are considered attractive in their potential for in-situ gasification, and two separate small scale test sites have been developed in Campbell County, Wyoming, one by the Department of Energy (Hoe Creek Site) and another by ARCO Coal Company.

In-situ gasification in this country is still in early experimental stages and a major disadvantage with in-situ gasification is that it does not produce pipeline quality gas. Thus, unless there are industries nearby that could use low or medium Btu gas, a surface facility must be constructed to upgrade the gas to pipeline quality. The National Coal Policy Project concluded that even if in-situ gasification experiments in the Powder River Basin prove to be successful, the distance of the region from centers of demand is likely to limit application of the technology (Murray, 1978). Furthermore, the experiments at the Department of Energy's Hoe Creek site have run into unexpected problems with subsidence over the burned out coal beds. An unplanned crater nine feet deep and 30 by 60 feet developed at the site in 1980, and the Wyoming Department of Environmental Quality is concerned about contamination of ground water from the burned out coal beds (Anderson, 1980).

In sum, Federal synfuels legislation has created a significant potential market for coal in the Powder River Basin and southern Wyoming. The question of "how much?" will probably be defined in terms of levels

promoted by government policy, possibly tempered by the acceptability of such projects by the local populace where the synfuels plants are located. (See Chapter 4 for discussion of socioeconomic considertions with onsite coal use.)

Severance Taxes. Severance taxes imposed by western states on coal that is exported to eastern markets, particularly Montana's 30% tax, have been the subject of considerable controversy. Legislation to set an upper limit on state severance taxes is not likely to pass Congress in 1980, but the importance of this issue will probably not diminish. Even if such legislation is passed, litigation over constitutional questions can be expected to delay and possibly prevent its implementation. The affect that severance taxes have on export markets for Wyoming coal is small compared to mining and transportation costs. In general, the relative unimportance of severance tax costs throughout the west is demonstrated by the fact that virtually all of the federal leases in Montana are in production.* Evaluation of undeveloped leases in Montana did not provide evidence that the Montana severance tax is a factor in the lack of development of presently undeveloped leases. Nevertheless, for reasons discussed in the next section, a ceiling on severance taxes of 12.5 percent, for example, could slightly improve the marketability of coal from the Montana portion of the Powder River Basin.

*Differing views of the significances of Montana's severance tax are discussed further in the section on relative market advantages and disadvantages of Montana coal in Chapter 4 (OTA, 1981).

Federal Pricing Policy. The fair market value and royalty rates associated with federal pricing policy have more significance for the leasing of additional federal coal than for the development of outstanding leases. The average royalty rate on federal coal mined in 1977 was 18.8 cents per ton. In contrast, the new royalty on surface mined coal leases will be 12.5 percent. If the cost of mining that coal is around $7.00 a ton, the "new" royalty rate will be about 88 cents, more than four times the royalty rate on the "old" federal coal. This increased royalty rate still does not represent a very high percentage of the delivered price of the energy, but it gives existing lease holders a strong competitive edge over the potential lessees of new federal coal when there is a buyer's market, and the potential for considerably increasing profit margins when there is a seller's market. However, because royalty rates on existing leases must be readjusted to statutory 1976 FCLAA rates when leases are adjusted, this differential will end for most leases within the next 10 years or so, provided the leases are adjusted.

Reclamation Laws.* Implementation of all requirements mandated by the Surface Mining Control and Reclamation Act of 1977 works to the advantage of western coal because reclamation costs will be proportionately higher in the midwest and Appalachia where coal seams are generally thinner. Typical reclamation costs for surface mining under SMCRA have recently been estimated to be $5.19/ton in Appalachia, $2.07/ton in the midwest and $0.24/ton in the west (National Research Council, 1981). A study of the added cost of reclamation under SMCRA found incremental costs much higher in Appalachia and the midwest than in the west (Skelly and Loy 1979). However,

*The economic impact of environmental requirements on the cost of mining western coal are discussed further in Chapter 9 (OTA, 1981).

Congressional efforts to relax the reclamation standards under state programs could lead to a reduction in the relative advantage that western coal has under the present regulatory framework established under SMCRA.

The issues discussed in this Chapter have been generic rather than region-specific because they affect all undeveloped federal coal leases, not just leases in Wyoming and Montana. The next three chapters examine the more specific regional environmental, infrastructure and market issues that may affect lease development in the study area.

CHAPTER 3. REGIONAL ENVIRONMENTAL ISSUES AFFECTING LEASE DEVELOPMENT

This chapter examines six regional environmental issues that affect federal lease development in the Powder River Basin and southern Wyoming: 1) air quality, 2) water resources, 3) reclamation, 4) areas unsuitable for mining and other requirements in SMCRA, 5) wildlife, and 6) non-federal coal and non-coal mineral developments. The relative importance of these issues differs between the Powder River Basin and southern Wyoming and depends on whether mine development is for export or onsite use. The environmental problems associated with mining coal for export are, of course, fewer than those associated with onsite use.

Air Quality.* The Wyoming Powder River Basin is presently a Class II air quality area, and while air quality considerations may constrain development on a site specific basis, it does not appear that regional air quality threshholds will restrict levels of production anticipated for the next ten years. The most salient air quality issue for coal mine development in Wyoming is the effect of fugitive dust from mining operations on ambient standards for total suspended particulates (TSP). The level of production that a mine can maintain without exceeding these standards is highly site specific. In the Powder River Basin, for example, the production capacity of ARCO's Black Thunder Mine is constrained by air quality considerations. DEQ rejected ARCO's application for an air permit for a maximum of 30 million tons/year. Instead, a permit was issued for only 20.5 million tons because the particulates from ARCO's mine and the nearby Jacob's Ranch mine were already near the ambient standard.

*Further discussion of air quality issues affecting the Powder River Basin can be found in Chapter 9 (OTA, 1981).

Air quality permits are usually obtained before a mine permit application is submitted. As a result, air quality permits have become a commodity with a distinct value. By late 1978, DEQ had issued air permits for 50 million tons of production on six federal lessees that did not have mine permit applications filed or under active review. Since then, WYMO Fuels has held an air permit for four million tons of coal production but has not actively tried to develop a mine on this tract because the reserves are too small without the addition of new federal coal. To counter this trend, DEQ recently implemented a policy requiring that an application include reserves sufficient to warrant the permit amount requested. DEQ issued Fort Union Coal Company a temporary air quality permit for five million tons that required the company to demonstrate that its mine could support this annual level of production. The company lost the permit after failing to provide DEQ with this information, but was issued a permit for 1.2 mty.

As of August, 1980, DEQ had issued air quality permits for existing and proposed mines in Campbell County that could accomomdate 245.5 million tons of coal production annually. This amounts to five times the total production from the Powder River Basin in 1979 and more than twice the likely maximum production in 1991 (see Chapter 5). Only three undeveloped leases with favorable development prospects do not have air quality permits--Dry Fork near Gillette,* and North Rochelle and Rochelle south of the Black Thunder Mine. DEQ could possibly restrict maximum production from both mines because they are located in areas of Campbell County that are at, or near TSP ambient threshholds.

*Dry Fork now has a permit for 15 mty (phone conversation with Richard Schrader, Wyoming Department of Environmental Quality, Sheridan, WY, May 22, 1981).

The Class I designation of the Northern Cheyenne Indian Reservation makes air quality considerations more significant in the Montana portion of the Powder River Basin. The Air Quality Bureau of the Montana Department of Health and Environmental Services has designated an area which encompasses the Colstrip and the Peabody Big Sky mines as a non-attainment area for TSP, and stringent stipulations for fugitive dust control have been made for the Big Sky mine expansion (USGS 1979a). Both of these federal leases have significant reserves that are not covered by current mining plans. Expansion of mining to develop additional reserves on these leases might be constrained by air quality considerations, although neither Peabody nor Western Energy are expanding mine operations at this time. The only other federal leases in Montana with favorable development prospects (PKS CX Ranch and CX Ranch) are probably far enough from the Colstrip non-attainment area to avoid development restrictions due to air quality problems.

Fugitive dust may also affect site specific mine development in southern Wyoming. The proposed Prospect Point Mine in Sweetwater County is currently having trouble getting permit approval because of air quality considerations. According to the Southcentral Wyoming Regional EIS (BLM 1978a) the Hanna South Mine may cause ambient TSP concentrations at the edge of the town of Hanna during the life of the mine that are greater than the permissable levels established for this area. Also, BLM has predicted that the annual TSP concentrations around the existing Medicine Bow Mine will continue to exceed the Wyoming air quality standard throughout this decade (BLM 1978a). On the other hand, the EIS regional modeling done on the combined air quality impacts of existing mines and the mines that could be developed on new federal coal leases in the Green River-Ham's Fork region (BLM 1980b) indicate that no air quality standards will be exceeded. A

change in the modeling method appears to be the main reason why the results of these projections are different. It is important to keep in mind that a change in the "rules" for granting air quality permits in the Powder River Basin could raise air quality threshholds.

When onsite synfuel or power plants are taken into account, air quality considerations become more complex. Class I areas have been proposed both for the Cloud Peak Primitive Area in the Bighorn Mountains west of the Wyoming Powder River Basin and for Devils Tower to the east. Air quality considerations might possibly constrain the total level of synfuels development in the Powder River Basin and southern Wyoming, but probably not during the next ten years. However, Wyoming's sulfur dioxide emission standard, which is considerably more stringent than the national standard (0.2 vs. 1.2 lb sulfur/dioxide/million Btu) could create difficulties for onsite development of coal reserves with high levels of sulfur. Two undeveloped federal lease tracts (the Belco tract in the western Powder River Basin and the Cherokee tract in southern Wyoming) that have reserves sufficient to supply a power or synfuels plant would require more than 95% sulfur reduction to meet the standard. Sulfur removal efficiencies exceeding 95% could be achieved, but the cost would be very high.

Water Resources.* Availability of water is generally not a major factor affecting coal mine development in the Powder River Basin, but could be a problem in southern Wyoming where irrigation is necessary to re-establish vegetation on mined lands. Furthermore, the increasing demand on municipal water supplies resulting from expanded coal production could

*Further discussion of water resource issues affecting lease development can be found in Chapter 9 (OTA, 1981).

cause difficulties for rural communities. The Green River-Hams Fork EIS indicates that the expanded water supplies needed by mining companies and municipalities will probably be met by acquisition of senior water rights currently held by ranches (BLM 1980a). Should this occur, less irrigation water would be available for agricultural uses. The EIS further states: "If adequate water rights required by coal-related development cannot be demonstrated at the time of preparation of an EIS for each proposed mine, presumably a mining permit would not be issued for that mine and no additional development would occur" (BLM 1980a).

The availability of water for onsite synfuel or power plant development and for coal transportation via slurry pipelines is a significant issue in both the Powder River Basin and southern Wyoming. Total water requirements from a typical water-cooled 1000 MW power plant in the Northern Great Plains ranges between 12,000 and 15,000 acre-feet/year, and for a 250 million scf/day coal gasification plant between 8,000 to 12,000 acre-feet/year (Northern Great Plains Resource Program 1974). Annual water requirements for a slurry pipeline are from 600 to 800 acre-feet per million tons of coal transported, or approximately 20,000 acre-feet/year for a 30 mtpy pipeline. A coal-water mixture in a coal slurry pipeline would consume about one-fifth the water needed for a coal gasification plant and secondary developments associated with the plant (letter to OTA from Harry Harju, Wyoming Game and Fish Department, Cheyenne, WY, December 23, 1980).

Scarcity of water justified the expense of constructing the first dry-cooling tower in this country at the Wyodak Power Plant near Gillette. Lake DeSmet, near Buffalo, has approximately 50,000 acre-feet/year of water available for industrial development (BLM 1979). Transporting water via

aqueducts from the Yellowstone River Basin would be the only other large source of surface water for the eastern Powder River Basin (Bureau of Reclamation 1972). In fact, the Bureau of Reclamation, (now the Water and Power Resources Service) has proposed such a project. Perhaps the greatest obstacle to this type of project is the Yellowstone River Compact, which requires agreement of all three states (Montana, Wyoming and North Dakota) for interbasin transfers of water from the Yellowstone River. The Montana-Wyoming aqueduct project has not been under active consideration for a number of years.

Wells in the Madison limestone, which underlies the whole Powder River Basin, may be a significant potential source of water with yields of more than 4,000 gallons of water per minute (Swenson 1974). The city of Gillette has proposed withdrawing up to 7,000 gpm from 14 wells (a maximum of 11,500 acre-feet/year) in the Madison limestone formation to supply water needs for a population of 35,000 in Gillette (population in 1978 was 12,000) and 1600 acre-feet/year for Black Hills Power and Light Company (State Engineers Office 1977). Energy Transportation Systems, Inc. (ETSI) has a permit to withdraw 20,000 acre-feet/year from the Madison formation for its slurry pipeline project. However, proposals to use water from the Madison limestone for slurry pipelines have met considerable opposition. The Governor of Wyoming has taken the position that legislation giving coal slurry pipelines eminent domain should require the use of nonwater-based coal slurry technologies.

Water can probably be obtained without great difficulty for a modest level of onsite synfuels and power plant development during the next 10 years in Wyoming and Montana, but in the longer term the availability of

reserves for such development probably exceeds the availability of water. Persse and Willard (1972) have estimated that full development of reserves for synthetic fuels in the Powder River Basin could require as much as 2.2 million acre-feet of water annually. A maximum of 150,000 acre-feet of water annually could be available from the Tongue River and the Powder River in Wyoming and Montana, which are the main drainage basins in the region (Northern Great Plains Resource Program 1974). Annual recharge of the Madison Formation in the Powder River Basin is about 75,000 acre-feet/year. Current withdrawals from the Madison Formation amount to about 25,500 acre-feet/year, not including ETSI's permit for 20,000 acre-feet/year. Permit application to withdraw water from the Madison formation in the eastern and western sections of the Powder River Basin total 695,000 acre-feet/year, but specific proposed uses would probably require 90,000 to 110,000 acre-feet annually. (State Engineers Office 1977.) If these permits are granted, total withdrawals from the Madison formation would be about double the annual recharge.

The impacts of mining on groundwater in the Powder River Basin have been a matter of controversy, primarily because groundwater is a significant source of water for domestic and livestock use. The most common problems identified in DEQ's review of mine plan permit applications are hydrologic, and about 80% of the litigation involving mines relates to impacts on groundwater (personal communication, Walter Ackerman, Wyoming DEQ). Mining in the Powder River Basin may dewater shallow wells within several miles of an active pit and, in the eastern section of the Basin, may lower the potentiomatic surface of the Wyodak Anderson coal aquifer (Keefer and Hadley 1976). Surface mining does not usually affect the amount of water flowing through an area, and in most cases groundwater flow patterns can be expected

to reestablish themselves after mining and reclamation is completed (Keefer and Hadley 1976). According to the Mining Task Force of the National Coal Policy Project, some areas with abundant springs, such as Sarpy Creek in Montana, are best not mined because of difficulties in reconstructing the aquifers that supply springs (Murray 1978). Subsidence due to underground mining may adversely affect surface and groundwater systems (Hill and Bates 1978). This may be a concern at the Carbon County mine in Carbon County where the seams being mined are overlain by several aquifers.

Surface mining can cause significant changes in the quality of groundwater. Data from mines in Montana, Wyoming and Colorado indicate that concentrations of dissolved solids in spoil waters average about two to three times those present in undisturbed coal aquifers (BLM 1980). Because the quality of water in these states is often of marginal suitability, further degradation caused by coal mining may render the water unusable without the added expense of treatment. To date, concerns about groundwater quality have not been significant in the permit process. However, degradation of groundwater by geochemical weathering and movement of contaminated groundwater is a slow process that may lead to environmental costs in the future. One permit application has already been rejected in Wyoming primarily because of groundwater considerations. Cumberland Coal Company's Twin Creek Mine proposal which would have intersected an artesian aquifer in Lincoln County was rejected because, an acceptable plan to protect the aquifer was not developed.*

*This mine proposal has subsequently been dropped and the Federal lease integrated into Kemmerer Coal Company's proposed North Block mine. Coal reserves near the artesian aquifers may be left in place, but most of the reserves on the least will probably be mined.

Revegetation. P.L. 95-87 establishes a stringent standard for revegetation of mined lands that is particularly challenging in the West. Section 515(b)(19) requires the establishment of a "diverse, effective and permanent vegetative cover of the same seasonal variety native to the area of land to be affected and capable of self-regeneration and plan succession at least equal in extent of cover to the natural vegetation of the area." The standard also makes allowances for use of introduced species where desirable and necessary to achieve the approved post mining land use plan. The use of introduced species in the west generally requires more intensive management to maintain optimum levels of productivity compared to restoration of native vegetation. This is generally not feasible in most areas of the west that will be surface mined because the added costs of intensive management usually do not increase productivity sufficiently to pay off. Consequently, most reclamation in the west involves reestablishment of native ecosystems.

Revegetation of surface mined lands has been the subject of considerable controversy in the west primarily because the arid and semi-arid climate makes the establishment and maintenance of vegetation more difficult than in the humid east. A study by the National Academy of Sciences (1974) concluded that areas receiving ten inches or more of annual precipitation can usually be reclaimed* provided that evapotranspiration is not excessive, landscapes are properly shaped and techniques demonstrated to be successful in rehabilitating disturbed rangelands are used. However, the NAS Committee concluded that in drier areas receiving less than 10 inches of precipitation, revegetation will be much more difficult and can probably be accomplished only with major sustained inputs of water, fertilizer and management. The committee used slightly less stringent criteria than in the

*The NAS Committee used the term "rehabilitation" rather than "reclamation" but in current usage, the two terms are usually used interchangeably.

SMCRA for defining successful reclamation, and emphasized that its conclusions were not based on long-term extensive controlled experiments in revegetation.

More recent studies that have evaluated revegetation practices in the West (Murray, 1978 and Wiener, 1980) have noted short term success in revegetation, but concluded that the long term success of revegetation through periods of extended drought have yet to be demonstrated, and that revegetation techniques remain essentially experimental in nature.

There is no dispute about whether vegetation can be established on mine land in the west; this has been accomplished through the use of irrigation and intensive management even in the driest areas such as the San Juan River Basin and southern Wyoming, and high levels of productivity have been measured at several reclaimed sites in the Northern Plains which have used fertilization and introduced species. However, disagreement exists as to whether native ecosystems with similar levels of productivity and resilience to the stress of drought can be established. Of particular concern is whether a suitable mix of native species can be established that provides good year-round pasture for livestock in the Northern Plains without requiring continued intensive management and whether desert and foothills-shrub vegetation associations that provide critical winter range for large game in the Rocky Mountain coal areas can be established.

Reclamation experts differ in the degree of optimism or perssimism with which they view the likelihood of success in reclaiming native ecosystems in the west, but there is general agreement that it will be a number of years before the question is resolved. It has been seven years since Montana passed the first reclamation law in the west that had stringent standards

for revegetation, and as yet no land reclaimed under that statute has developed a vegetative cover that qualifies for bond release.* A recent study by the Committee on Soil as a Resource in Relation to Surface Mining for Coal of the National Academy of Sciences concluded that the ten year time period specified in the SMCRA for bond liability after reclamation is completed may not be long enough to demonstrate success of revegetation in the arid areas of the west (National Research Council, 1981).

Revegetation is a significant concern with respect to reclamation of alluvial valley floors because in the Powder River coal basin in particular, the ranching economy depends in large measure on the high productivity of these lands. Aside from alluvial valley floors, the issue of revegetation has not had a significant impact on the availability of federal coal under existing lease for development. The main reason for this is that while regulatory authorities recognize that uncertainties remain concerning the long term success of current revegetation practices, they apparently do not feel that the probability of serious failure is high enough to justify rejecting a permit application on the basis of difficult conditions for revegetation. This judgment is evident in the Department of the Interior's decision on the petition to designate the Alton area in southern Utah as unsuitable for mining. One of the arguments made in the petition was that conditions in the area were too difficult for successful reclamation because of the nature of the soil and arid climate. The Department of the Interior concluded that revegetation would be successful. (U.S. Office of Surface Mining, 1980).

*Personal communication with Bruce Hayden, Administrator of the Reclamation Division of the Montana Department of State Lands.

It is apparent that unless there are dramatic failures in revegetation involving state-of-the-art reclamation practices in the next ten years, it is unlikely that difficult conditions for revegetation will prevent any existing federal coal leases from being developed. However, concern over revegetation has required, and can be expected in the future to require modification of mining plans. For example, the Office of Surface Mining has concluded that the Black Butte Mine in southern Wyoming has very difficult conditions for revegetation and has required the ue of a sprinkler irrigation system.

Areas Unsuitable for Mining and Other Requirements in SMCRA. Section 522 of the Surface Mining Control and Reclamation Act of 1977 specifies a number of situations where mining may be restricted or prohibited. Table 3.1 lists these prohibitions, and the exceptions to them, in areas designated specifically as unsuitable for mining. The designations that are most likely to affect lease development in the Powder River Basin and southern Wyoming are 1) places listed on, or eligible for listing on the National Register of Historic Places, 2) public roads, 3) occupied dwellings, and 4) public buildings.

Mining may be allowed in many situations involving public road right-of-ways and occupied dwellings because the operator can obtain waivers, purchase the occupied dwellings, or relocate roads. However, the law does not allow exceptions to the prohibition of mining near a public building. This regulation could restrict the development of surface coal reserves in the Gillette and Hanna areas in Wyoming, but OTA has not identified any federal leases where this will definitely occur. However, since the town of Gillette has expanded onto the surface of the southern

Table 3.1

EXCEPTIONS TO PROHIBITIONS AGAINST MINING (OTHER THAN VER[1/])

IN AREAS DESIGNATED "UNSUITABLE" BY CONGRESS

	Citation
National Parks. No exceptions.	761.11(a)
National Wildlife Refuges. No exceptions.	761.11(a)
National System of Trails. No exceptions.	761.11(a)
National Wilderness Areas. No exceptions.	761.11(a)
Wild and Scenic Rivers (and rivers designated for study). No exceptions.	761.11(a)
National Recreation Areas. No exceptions.	761.11(a)
National Forests.	
Custer National Forest. No exceptions.	761.11(b)
Other Forests. Exceptions possible. Allowed if Secretary of Interior determines that mining is compatible with recreational, timber, economic or other values AND (1) surface effects are related to an underground mine OR (2) where areas with no significant forest cover are to be affected in National Forests west of the 100th Meridian, the Secretary of Agriculture determines that the mining operations will comply with applicable laws pertaining to National Forests.	761.11(b)
Land which will adversely affect (a) publicly owned parks or (b) places listed on the National Register of Historic Places. Exceptions allowed if approved jointly by the regulatory authority and the federal, state or local agency with jurisdiction over the park or place. 761.12(f) sets procedures in this situation.	761.11(c)
Publicly owned parks (including 300 foot buffer zone). No exceptions. Lands which might adversely affect a publicly owned park may be mined with appropriate approval (see preceding item), but there is no exception to mining a park itself.	761.11(f)
Public road right of way (including 100 foot buffer). 2/ Exception allowed when mine access roads or haulage roads join right of way line. After public notice and opportunity for a public meeting and the agency with jurisdiction over the road makes a written finding that the interests of the affected public and landowners will be protected, the regulatory authority may (1) allow relocation of the road or (2) allow mining to come closer than 100 feet of the right of way.	761.11(d)
Occupied dwelling (including 300 foot buffer). Exception allowed if owner has signed a written waiver consenting to mining closer than 300 feet. 761.12(e) sets procedures in this situation.	761.11(e)
Public building, school, church, community or institutional building (plus 300 foot buffer). No exceptions.	761.11(f)
Cemeteries (including 100 foot buffer). No exceptions. The preamble to the regulations notes that nothing in the Act prohibits relocation of cemeteries under state law before an operator applies for a permit.	761.11(g)

Footnotes:

1/ Valid existing rights in existence on August 3, 1977 in areas designated unsuitable for mining are honored in all cases. See definition of VER 761.(a)-(d). Determinations by the regulatory authority concerning VER are subject to administrative and judicial review under 787.11(b) and 787.12(b)(1).

2/ The preamble to the regulations states that mining under a road should not be prohibited where it would be safe. This would apply to publicly owned parks, places listed on the National Register of Historic Places and the other areas listed in this Table. However, the burden of proof would be on the operator to show that subsidence or other adverse surface effects would not occur at any time in the future.

Source: Boulding (1980)

part of the South Rawhide lease, mining the reserves on that part of the lease is essentially precluded.

The disturbance of archeological sites by mining may have a direct bearing on the development of existing federal leases. Few, if any of the sites listed on the National Register of Historic Places are likely to be affected by lease development, but such development may well affect sites eligible for listing on the National Register. Depending on how this issue is resolved, archeological sites of special value (i.e. those eligible for listing in the National Register) could cause delays in mining, add expense to salvage excavations, and possibly prevent mining in some locations. In the Powder River Basin OSM has identified potential cultural resource problems at the following mines: Rojo Caballos, Black Thunder, Coal Creek, Dave Johnston, Buckskin, North Rawhide, Pronghorn, Cordero, Antelope, and East Gillette (personal communication, Judy Schafer, OSM, Denver).

SMCRA's regulations pertaining to the mining of alluvial valley floors (AVF) have the potential to restrict federal lease development significantly in the Powder River Basin of Montana and Wyoming.* In fact, compared to AVFs, other unsuitability criteria are relatively unimportant in the Powder River Basin. In the Gillette area, for example, 60,900 acres of potential alluvial valley floor have been identified which cover almost 60% of the available unleased federal coal reserves (BLM 1980).** But only 1,800 acres, or 2 percent of available reserves, are unsuitable for mining in the

*Further discussion of AVF issues, along with estimates and status of reserves affected by AVFs can be found in Chapter 9 (OTA, 1981).

**See Appendix 6 (Volume II) for further discussion of potential AVF in the Gillette area.

same area because of buffers around dwellings and highways. An additional 60 acres was eliminated near Gillette due to a golden eagle nest and a prairie falcon nest.

Sections 510(b)(5) and 515(b)(10)(f) in SMCRA refer to alluvial valley floors. The first section does not allow mining that would: 1) interrupt, discontinue or preclude farming on alluvial valley floors that are irrigated or naturally subirrigated, or 2) materially damage the quality and quantity of surface and groundwater that supply the valley floor. The relatively few federal leases in the Powder River Basin that include alluvial valley floors with agricultural significance are located mostly in the Tongue River basin in Sheridan County, Wyoming and in Bighorn County, Montana. AVF requirements in SMCRA will cover expansion of either the Decker or Bighorn Mines, both of which are mining alluvial valley floors under a provision of the Act which allows mining operations to continue if they were already underway when SMCRA was first legislated. However, any expansion of these mines involving new permit areas will have to comply with AVF regulations. Agriculturally important alluvial valley floors will probably prevent the development of parts of federal leases on the CX Ranches and the PKS CX Ranch in Montana. As a result, the recovery factor from mining on these leases will only be 30% compared to the 90% recovery factor more typical of surface mines in this area. The Lake DeSmet lease block in Johnston County, Wyoming, contains an estimated 400 million tons of reserves under alluvial valley floors (BLM 1979a), and the Cordero Mine has federal reserves along the Belle Fourche River in Campbell County with agriculturally significant AVFs.

The second reference to alluvial valley floors in SMCRA covers environmental performance standards. The Act says that the essential hydrologic functions of alluvial valley floors in the arid and semi-arid west must be preserved throughout the mining and reclamation process. This stipulation is an elaboration of those requirements in the Act which minimize disturbance of the hydrologic balance. The requirement applies whether or not the alluvial valley floor is agriculturally significant. At least seven developed leases (Buckskin, North Rawhide, Eagle Butte, Belle Ayre, Coal Creek, Jacobs Ranch and Black Thunder) in the Powder River Basin contain alluvial valley floors that are not agriculturally significant, but which require careful attention to the essential hydrologic functions. Two of these mines--Buckskin and Coal Creek--have large reserves under this kind of alluvial valley floor.

The major environmental uncertainty affecting lease development in the Powder River Basin is determining whether or not the AVFs can be mined without destroying their essential hydrologic functions. Restoring and maintaining through-flowing drainage ways will be especially difficult in the Gillette area because the mining of the thick Wyodak-Anderson coal bed will appreciably lower the ground surface. This may create extensive closed depressions through which it will be difficult to reestablish pre-mine drainage patterns. Equally important is the potential for gullies to develop along the stream channels upstream from the highwalls bringing increased erosion and sediment yield both inside and outside the mined area (Keefer and Hadley 1976).

No developed leases in southern Wyoming have alluvial valley floor problems but some undeveloped leases and PRLAs in this area may be affected

by AVF provisions in SMCRA. The Twin Creek, North Block and North-North Block lease blocks west of Kemmerer, Wyoming, are adjacent to the alluvial valley floor next to the Hams Fork River. Mining will probably not be restricted on the North Block lease since the coal beds dip away from the AVF. However, the mining of some reserves may be restricted on the North-North Block tract which crosses the river valley. The Bean Springs PRLA probably includes alluvial valley floors but information is insufficient at this time to determine if mining should be restricted. Establishing stream gradients may be a problem in southern Wyoming even where alluvial valley floors are not present. The mining of dipping seams on undeveloped leases in the Hanna Basin could lead to difficulties in reconstructing steep-sided draws.

A recent survey of plans for coal mine expansion in Wyoming found only one out of 52 existing and proposed mines identified by the operator as possibly including prime farmland (ICF 1980a). Most soils in the region do not meet the SCS criteria for prime farmlands, and OTA did not identify any undeveloped federal leases where prime farmlands were known to be present. However, the stringent prime farmland soil reconstruction requirements in SMCRA would apply to any leases eventually classified as prime farmland.

Wildlife. As with reclamation, the potential for conflict between coal development and environmental values (the protection of wildlife) differs significantly in the Powder River Basin and in southern Wyoming. This difference is particularly evident with respect to the impacts of mining on large game. There is a direct relationship between habitat destruction and reduction in game herds in the Powder River Basin where herds generally graze the same areas in winter and summer. In southern Wyoming, on the

other hand, game herds follow regular migration routes and depend on relatively small areas of critical winter range to survive the winter. Elimination of this critical habitat has a proportionately greater adverse affect on animal populations than disturbance of summer range.

With the exception of the Jim Bridger Mine, which is mostly covered by critical habitat for antelope and mule deer, most mine development in southern Wyoming to date has not been located in areas designated as critical by the Wyoming Game and Fish Department. However, a number of proposals for the development of coal mining in southern Wyoming could easily conflict with the preservation of wildlife values. The Red Rim tract presently proposed for leasing includes over 2,000 acres of critical winter range for antelope. Several other proposed mines, such as Red Desert and Atlantic Rim (see Map 2, Appendix 1--the Red Desert Mine is not shown, but would be located northeast of the Cherokee Mine), have significant areas of critical wildlife range, and a competitive lease application by Idaho Power Company in southern Carbon County was rejected several years ago because of wildlife considerations.

Critics of the Wyoming Game and Fish Department's opposition to these mine development proposals in southern Wyoming have argued that data is insufficient to determine the critical winter range for large game. OTA was not able to evaluate this criticism on a site-specific basis, but did compare areas identified as critical by the Wyoming Game and Fish Departmment (1979) with data on wildlife presented in the southcentral and southwest Wyoming Environmental Impact Statements (BLM 1978a and 1978b). This comparison indicates that the Department is rather conservative in indentifying areas of concern for large game. For example, the EISs

identified seven leases (Seminoe No. 1, Black Butte, Hanna South, Cherokee, Long Canyon, Twin Creek and South Haystack) as being partly or completely covered by antelope, elk or mule deer winter range. However, current areas of critical winter range mapped by the Wyoming Game and Fish Department show winter range only on the Long Canyon lease.

In many respects, controlling the impacts on wildlife from population increases associated with mine development may prove to be more difficult than controlling the impacts of mining. If critical range is protected from mining, the number of acres disturbed is relatively small compared to available habitat. Protecting habitat from urban development associated with mine development, however, may not be as easy to achieve. For example, the development of a uranium mine in Sweetwater County resulted in a squatter settlement of about fifty families in the middle of critical winter range for antelope. In the Powder River Basin, the Wyoming Game and Fish Department anticipates a 14% reduction of deer herds in Campbell County by 1985 due to road kill, poaching and loss of habitat from mining (Powder River Basin Resource Council 1977).*

Hunting is considered an important element in the quality of life of many residents in Wyoming. Understandably, considerable political opposition could be expected if a specific mine proposal were perceived as seriously interfering with that sport. Such opposition could possibly affect development of six PRLAs in the Savery area in southern Carbon County which would expand population in a relatively undeveloped area where residents of Cheyenne hunt and which contain critical winter range for deer, elk and antelope. In this case, however, other more significant factors

*The complete loss of habitat in mined areas assumed in this estimate is probably overly pessimisstic.

than wildlife concerns could adversely affect lease development (see PRLA Summary Sheets, P24-29, Appendix 2).

The preceding discussion has focused on the impacts of mining on big game. Mining may affect other wildlife values as well. Eight out of 13 developed leases in the Powder River Basin and five out of 12 developed leases in southern Wyoming are completely or partly covered by critical habitat for upland game birds. Several black-footed ferret skulls have been found on, or near the South Haystack and Rosebud mines in southern Wyoming. Rare plant species have been found within or adjacent to lease boundaries at the Lake DeSmet block (Brownish sedge), North Block (Abies lasiocarpa -pinus contorta community), Twin Creek (stemless wild buckwheat), and South Haystack (malt saltbrush and stemless wild buckwheat) (Wyoming Natural Heritage Program 1980). However, neither the presence of critical habitat nor evidence of an endangered species or rare plants have prevented mining in any of these areas. Thus, these concerns are not likely to deter the development of federal leases.

Mine development has been affected by the presence of golden eagle nests in several places. The presence of an eagle nest at the Elkol-Sorenson mine in Lincoln County required revision of mining plans to avoid the nest area. An eagle nest on an old highwall at the Seminoe No. 1 Mine prevented backfilling that DEQ would normally require. The presence of an eagle nest at the Caballo mine in Campbell County would have prevented the mining of some reserves if the company had not succeeded in attracting the eagles to a nesting platform that was then gradually moved out of the mine area.

These problems have occurred because regulations under the Bald Eagle

Protection Act require protection of golden eagle nest sites equal to that required of bald eagle nest sites even though, in Wyoming, golden eagles are much more common than bald eagles (5000 golden vs. 20 bald eagles). According to a spokesman for the Wyoming Fish and Game Department, the U.S. Fish and Wildlife Service should promulgate regulations allowing variances from the prohibition against destroying or moving abandoned golden eagle nests which create problems for mine development because this is preferable to amendment of the Act to remove protection for eagles (personal communication, Harry Harju, Wyoming Game and Fish Department, Cheyenne).

In summary, wildlife values have not been a significant factor affecting lease development in Wyoming, but significant conflicts may develop in southern Wyoming in the future, particularly with respect to the impacts of mining on large game animals. These conflicts may occur because, compared to the Powder River Basin, southern Wyoming has more diverse wildlife habitats which coincide more frequently with coal areas. This pattern is evident both in the overlap of coal areas with critical big game habitat and the location of rare and endangered species, plant communities and aquatic habitats. A total of 14 lease blocks and 12 PRLA blocks in Wyoming are located in townships which contain rare plant or animal species and communities. Twelve of the lease blocks and six of the PRLA blocks are located in southern Wyoming (Wyoming Natural Heritage Program 1980).

Non-federal Coal and Non-coal Mineral Developments. Many environmental issues are site specific and must be resolved at that level. In the areas of air quality, water availability, and wildlife impacts there may be threshhold levels beyond which the cumulative impacts of coal development may no longer be acceptable. Little effort has been made to identify such

threshholds systematically, but available information indicates that such threshholds are not likely to be exceeded during the next ten years. However, evaluation of the relationship between federal lease development and environmental threshholds should also consider the impacts of non-federal coal development and non-coal mineral development in any region.

In the eastern Powder River Basin the federal government owns such a large percentage of coal reserves (about 80%) that non-federal coal development is insignificant. In the western Powder River Basin of Wyoming and Montana, however, significant blocks of private and state coal are held under lease by companies that have the financial capabilities to develop mines. In addition, the recent agreement between Shell Oil Company and the Crow Indian Tribe has opened the prospect for production of significant amounts of Indian coal in the Montana portion of the Powder River Basin.

The southern Powder River Basin includes several uranium districts which overlap areas of strippable coal in Converse and Campbell Counties. In 1979, seven uranium mines, employing over a thousand people, were operating in the southern Powder River Basin. Southern Wyoming had 16 uranium operations within or near the coal areas that employed about 4,000 people in 1979 (State Inspector of Mines 1979). According to the 1979 Mines and Minerals Map of Wyoming (Hausel et. al. 1979), at least 6 uranium mines are proposed for southern Wyoming (not including several proposed in the Gas Hills and Shirley Basin uranium districts to the north and east) and at least 11 new uranium mines are proposed for the southern Powder River Basin. To date, the cumulative impacts of coal development and uranium development have not reached a point of disturbance where environmental threshholds have been clearly exceeded. However, more extensive environment assessments

could reveal conflicts between the development patterns of these two energy resources. Coal areas in the Powder River Basin also coincide with oil and gas producing districts which place some constraints on the location of areas of federal coal that are suitable for new leasing.

CHAPTER 4. . REGIONAL INFRASTRUCTURE ISSUES

Two important regional infrastructure issues affect lease development in the Powder River Basin and southern Wyoming: 1) the availability of coal transportation and 2) socioeconomic impacts. In both regions, these issues may have a direct bearing on the location and rate of federal coal production.

Transportation. Most undeveloped federal coal leases in the Wyoming Powder River Basin are located within fifteen miles of existing rail lines. It is not altogether clear, however, if the existing rail lines have the capacity to transport the coal that could be produced in that region. The recently constructed rail line from Gillette to Douglas, a joint venture of Burlington Northern (NB) and the Chicago and Northwestern Railroad (CNW), has greatly improved the coal export capability of the Powder River Basin. Because CNW's track across northern Nebraska cannot accommodate coal unit train traffic, the increased transport of coal by CNW depends on the use of the Union Pacific track to the south (see Figure 4.1). However, CNW is currently not able to connect with the Union Pacific rail lines because Burlington Northern refuses to share its line from Orin Junction to Torrington. CNW's proposals to construct a new line from Van Tassel to Torrington to bypass the BN track has met with considerble opposition from residents along the proposed new track.

According to a recently released national energy transportation study, funded by the Departments of Energy and Transportation, the greatest potential bottlenecks for rail transport during the next ten years are the rail lines running east from the Powder River Basin through Nebraska and Iowa to Missouri and south through Colorado to Texas. The Union Pacific

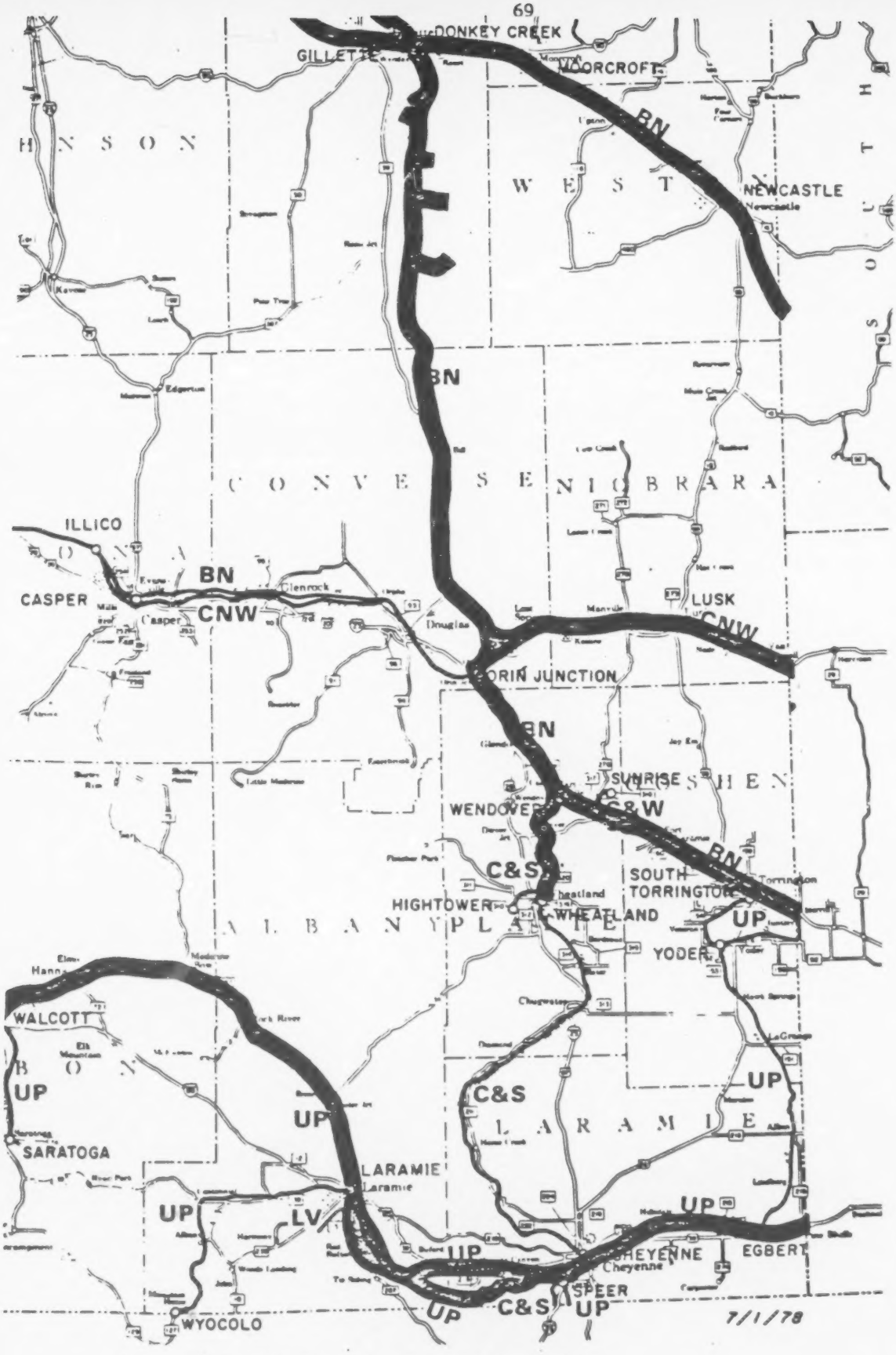


Figure 4.1 Rail lines in Eastern Wyoming

Railroad is better able to transport coal out of Wyoming than either Burlington Northern or CNW because it has doubletracks and heavier gauge rail. All undeveloped existing leases with favorable development prospects in southern Wyoming are within 5 miles of existing rail lines. However, the approximately 30 miles that separate the Bean Springs PRLA in Sweetwater and the closest rail line is the main reason why this PRLA has such poor development prospects.

According to recent testimoy presented by coal company officials at hearings before the House Commerce Oversight Subcommittee,* rail transport problems already exist in the Powder River Basin. In 1978, the Big Sky Mine experienced a shortfall of 200,000 tons of the total planned production of 2.3 million tons because of car shortages and rail scheduling difficulties. Several potential customers approached by Peabody Coal Company expressed concern about the adequacy and dependability of rail service from the region, and one customer even refused to enter into a purchase agreement until rail competition increased within the basin. Panhandle Eastern is seriously considering building its own rail line parallel to the BN-CNW line some 40 miles from the Rochelle mine in Campbell County to its proposed gasification plant in Converse County. Panhandle Eastern may find that building its own line is less costly than paying the high rates charged by Burlington Northern.

ARCO's Black Thunder and Coal Creek mines are operating far below capacity but, according to company officials, Burlington Northern is even

*Hearing conducted on rail rates in the Powder River Basin, November 15, 1979. The discussion on this and the following paragraphs draws exclusively from the testimonies of these hearings.

having difficulty hauling the coal already being mined under contract. In 1977, transportation difficulties forced ARCO to ship less coal than stipulated in its contracts. The cycle time (the time needed for a round trip and unloading at the destination point) for shipments to Southwest Public Service's Barrington Station in Amarillo, Texas, jumped from the 87.5 hours stipulated in a 1977 contract with Burlington Northern to 124 hours in 1977 and 190 hours in 1978. As a result, the utility had to increase the number of unit trains and substitute coal from other basins.

After 1985, slurry pipelines may provide an alternative means for transporting coal from the Powder River Basin. Energy Transportation Systems, Inc. (ETSI) is planning construction of a 1400 mile coal slurry pipeline from the Powder River Basin to Louisiana. The pipeline will be able to transport 25 to 37.5 million tons a year, depending on its size (38 or 40 inch). ETSI presently holds options with System Fuels for delivery of 10 million tons/year and appears to have overcome most of the legal and institutional barriers that could prevent construction of the pipeline.

In 1974, the Wyoming State Legislature passed a bill specifically authorizing export of water from the state through the pipeline and ETSI obtained the permit to withdraw 20,000 acre-feet/year from the Madison formation. Between 1974 and 1979, in spite of legal challenges by the railroads, right-of-ways were obtained to cross all railroads along the pipeline route. Necessary air quality permits were obtained in 1980, and a draft environmental impact statement was issued in late 1980 covering right-of-ways over a total of 38 miles of federal land to be crossed by the pipeline. A final decision by the Department of Interior on these right-of-ways is expected in 1981. Construction of the pipeline is

scheduled to begin in late 1982, with operations planned for 1984 or 1985.

ETSI's project is the only slurry pipeline proposal in the region to have reached this level of development. However, there are a number of unresolved legislative and water resource issues that continue to impair slurry development, including lack of eminent domain and the recent position taken by the governor of Wyoming that slurry pipelines should not be developed unless they use non-water based technologies. For these reasons, it is difficult to predict how this mode of coal transportation will affect rail costs and bottlenecks.

Another concern surrounding rail shipments of coal in Wyoming is how such transportation affects local communities. A study (Morris 1978) of the impact of coal transportation from the Powder River Basin on the town of Gillette concluded that, by 1985, between 18 and 31 trains could be passing through Gillette daily, resulting in separation of community services and an increase in safety hazards, noise and vibration. If new grade separations are not constructed in Gillette, car traffic blockages at railroad crossings could range from 5 to 9 hours a day. This situation could even be worse for communities close to the rail line southeast and south of Gillette where between 62 and 125 trains per day are likely to pass.

Between 1968 and 1978, grade crossing accidents in Wyoming increased tenfold from seven to 74. During this same period, however, the number of accidents involving injuries at grade crossings increased at a lower rate, while the number of annual fatalities remained relatively constant (Voorhees and Associates). According to the Draft Wyoming Rail Plan, 13 communities in the state may be adversely affected by the inconvenience, delays, and accident hazards at grade crossings caused by increased rail traffic

(Voorhees and Associates 1980). There are more communities in southern Wyoming than in the Powder River Basin that may have to contend with such conflicts because rail traffic in this area includes the transport of commodities other than coal. Furthermore, the potential for urban/railroad conflicts resulting from the increased transportation of coal from the Powder River Basin is probably greater in the numerous communities located outside of the state to the south and east of the Basin. Coal from the Powder River Basin passes through relatively few communities in Wyoming.

Coal development has both direct and indirect impacts on highway systems. Coal haul roads must usually be constructed to service new mines, and highways may need to be relocated to allow maximum recovery of coal reserves. Existing highways are subject to heavier use and more rapid deterioration caused by haulage of coal mine equipment and machinery, new work force traffic, and heavier use due to the growth of communities stimulated by coal industry expansion. Most roads in the Powder River Basin and southern Wyoming were not constructed for traffic levels that may be associated with coal development. One five axle coal truck carrying a legally acceptable load causes the same stress on a mile of road as 2300 autos. The Wyoming Highway Department can do little to prevent mining companies from using highways until road damage due to coal haulage actually occurs. In one instance, however, at the PSO No. 1 mine in Sheridan County, the Wyoming DEQ prevented a coal company from using highways to haul coal because of the safety hazards that would be created for other users of the roads.

Socioeconomic Impacts

Both the Powder River Basin and southern Wyoming have experienced

adverse socioeconomic impacts from coal development. Rock Springs, located in Sweetwater County, Wyoming, provides a classic case study of "boomtown" phenomena (Gilmore and Duff 1975). An increase in population from 18,931 to 36,900 has resulted from an expansion of mining for the mineral, trona, and from construction of the Jim Bridger Power Plant from 1970 to 1974. The quality of municipal and other local services declined markedly. In Sweetwater County, the ratio of doctors to population decreased from 1:1800 in 1970 to 1:3700 in 1974, in contrast to an average ratio in the state of 1:1100. In 1974, county schools were short an estimated 128 schoolrooms; approximately 1,397 homesites needed municipal services (i.e., water, sewage, roads, and electricity); and 4,599 mobile-home spaces were needed. Caseloads in mental-health clinics increased eightfold. Crime rates increased by 60 percent between 1972 and 1973 alone, while police services remained relatively constant. During an oil boom in the 1960s, the adverse psychological effects of rapid growth (alcoholism, divorce, suicide, etc.) were so pronounced in the town of Gillette located in Campbell County that the phenomena has been termed the "Gillette syndrome."

An early study of the socioeconomic impacts of increased coal development in the Northern Great Plains (Northern Great Plains Resource Program 1974) reached the following conclusions:

- Population increases attributable to coal development will be large and attendant problems will be compounded because such increases will be both rapid and unevenly distributed.

- Most communities in the Northern Great Plains are not prepared to deal with the magnitude of change attending regional coal development.

-- The rapid influx of population will cause a proportionally greater increase in demand for services because newcomers often have higher expectations for services than native residents.

-- Public service requirements will increase at a much faster rate than revenue collection, especially in the early years of development. The service areas of particular concern are housing, health care and education.

These conclusions have generally been confirmed by subsequent experiences in the region, although some of the larger communities in the Powder River Basin such as Sheridan and Gillette (1978 populations of 15,950 and 12,500 respectively) have leadership in local government capable of dealing with growth in a sophisticated manner. A recent study of the fiscal impacts of energy development on local government in Wyoming (Stuart/Nichols Associates 1979) estimates that the cost of capital facilities required between 1979 and 1985 will be $446.6 million, yet the debt capacity of counties, cities and towns is generally only one-quarter to one-third of this figure. All potential sources of funding for local government requirements (local debt capacity, potential state and federal aid--see Table 4.1) were estimated to fall short by $27.6 million during the 1979-1985 time period. This study assumed a lower inflation rate than recent rates, so shortfalls may be even higher.

The U.S. Department of Energy (1978) considers a 3% average annual growth in population to cause "severe" impacts and a 5% average annual growth rate to cause "critical" impacts in sparsely settled areas. Because such areas characterize most of the Powder River Basin and Southern Wyoming, growth rates exceeding 3 to 5 percent can be expected to create difficulties

TABLE 4.1 LOCAL GOVERNMENT CAPITAL REQUIREMENTS AND POTENTIAL FINANCING

1979 to 1985

Local Government	Total Capital Requirements (millions)	Local Debt Capacity (millions)	Potential State Aid (millions)	Potential Federal Aid (millions)	Potential Surplus (Deficit)
Counties	$ 85.3	$30.3)	$165.6	$67.5	($3.6)
Cities & Towns	257.8	59.9)			
School Districts	103.5	77.8	1.7	--	(24.0)
TOTAL	$446.6	$168.0	$167.3	$67.5	($27.6)

Source: Stuart/Nichols Associates (1979)

for local governments. Campbell County and Sheridan County have projected annual growth rates of 6.9% and 11.2% respectively between 1979 and 1985, and most communities in the Powder River Basin are expected to experience average annual growth rates greater than 3% (Stuart Nichols Associates 1979).

Evidence indicates that communities in both the Powder River Basin and southern Wyoming can assimilate population increases that result from coal industry expansion without the most severe problems associated with rapid growth. In the Powder River Basin, for example, careful planning appears to be controlling some of the problems remaining from earlier rapid development. A new town, built to house workers at mines south of Gillette, was able to accommodate a population of 1,400 within three years after construction first began (Huff 1980). Construction has already begun on the new town of Spring Creek in Bighorn County, Montana (Cumin 1980). In spite of any increase in population resulting from mine developments in Montana, and without the benefit of associated increases in property taxes and severence taxes from the mine development, the town of Sheridan, Wyoming, has successfully accommodated growth to date, although the county has serious problems obtaining sufficient funds for the general budget to meet operating expenses (Pernula 1980). Also, increased housing costs, due in large part to energy development, have created hardships for elderly residents of Sheridan on fixed incomes (Primack 1979).

A major problem for local communities is that the unsettled nature of the national economy makes it difficult to predict levels of coal development accurately. Communities such as Gillette are presently preparing to absorb additional large increases in population due to coal

development. If conservation efforts continue to reduce the electrical growth rate and economic recession continues throughout the country, expectations of demand for coal from the Powder River Basin may not be achieved. If development falls short of levels for which a community has expanded services, existing residents will have to pay for capital investments that were made on the assumption that there would be a larger population to share the cost.

The Wyoming Industrial Siting Administration has set an important precedent by requiring coal companies to help mitigate the socioeconomic problems caused by coal mining as a condition for getting permit approval. The permit for Carter's North Rawhide expansion, for example, includes stipulations that the company: 1) monitor housing in the Gillette area through annual updating of the city's housing study, 2) allow annexation of 240 acres of land owned by Carter south of Gillette, when the city needs it for housing, 3) provide a five-acre school site, 4) supply labor and equipment for city drainage projects between 1980 and 1982, and 5) fund a $20,000 feasibility study on converting a school into city offices. Similar kinds of stipulations have been added to the siting permit for the East Gillette Federal mine near Gillette. The Rojo Caballos mine south of Gillette is also likely to have socioeconomic stipulations in its permit (Office of Surface Mining 1980).

The socioeconomic impacts that will result from the development of onsite power plants and synthetic fuels plants will be more extensive than the impacts associated with coal production for export markets because coal conversion projects require larger work forces for construction and operations. Socioeconomic threshholds as defined by the Wyoming Industrial

Siting Administration do not appear to pose any limits to the possible level of on-site development during the next ten years in either the Powder River Basin or southern Wyoming. However, strong local opposition in some areas is a factor that could adversely affect or prevent the development of synthetic fuels in both these regions. This is particularly true in the Western Powder River Basin of Wyoming where many agricultural communities are located, and in the Montana Powder River Basin, where local agricultural interests have organized into a potent political force.

There appears to be general acceptance in the Powder River Basin of coal mining for export, but the construction of large synthetic fuel plants represents a quantum jump in social and environmental impacts that could create strong resistance from local groups. Such coal development would also pose a threat to the traditional values of the agricultural community in the Powder River Basin (Gold 1974) where the difficult-to-quantify "quality of life" considerations could result in adversely affecting development of individual federal coal leases. For example, the Lake DeSmet lease, which must be developed on site, is located in an area where strong local opposition can be expected (Powder River Basin Resource Council 1980). Where mining and other mineral exploitation has occurred in southern Wyoming, however, the populace is generally more receptive to the idea of large-scale coal development.

Another issue associated with coal development in Wyoming is the increased demand for outdoor-related recreation (hunting, fishing, camping, hiking, nature photography) and the subsequently decreased quality and quantity of such recreational activity. In 1972, there were 7,799 licenses of all types (hunting, fishing, trapping) sold in Campbell County, 6,525 in

Converse County, 8467 in Johnson County, and 18,119 sold in Sheridan County.* By 1979, largely in response to mineral development, these totals were 12,618 (Campbell), 11,165 (Converse), 13,583 (Johnson) and 25,092 (Sheridan). Overall in this region, this represents a 65% increase in seven years. For the most part, these people leave Converse and Campbell Counties to hunt deer, elk, moose and game birds not available in those counties.

At the same time that demand has increased, hunter success for deer has declined from 80% to 61%, and for elk from 45% to 31%. This means there has been a large increase in hunters and a resultant decrease in hunter success. With this decline in the quality of hunting, the Wyoming Game and Fish Department has been getting complaints from hunters. At the same time, hunters do not recognize that the increase in their number is due to new residents. As a result, they have been pushing for restrictions on hunting by nonresidents, who provide most of the funding for the Game and Fish Department. A decrease in funding will affect the Department's ability to handle wildlife-oriented development problems.

*This data and the following discussion comes from a letter to OTA from Harry Harju, Wyoming Game and Fish Department, Cheyenne, WY, dated December 23, 1980.

CHAPTER 5. REGIONAL MARKET ISSUES AFFECTING LEASE DEVELOPMENT*

A key question concerning federal lease development in the Powder River Basin and southern Wyoming is whether coal production from the two regions is likely to be supply constrained or demand constrained. Generally, if demand for coal exceeds current levels of production, then a strong market will exist for undeveloped leases, and those with favorable development prospects are likely to be brought into production. If, on the other hand, available coal exceeds demand, then coal from undeveloped leases will not easily find markets. Where coal production is constrained by lack of demand, production from undeveloped leases will not necessarily be prevented, but development will occur for reasons other than a strong current market for coal.**

Factors Affecting the Demand for Coal from the Two Regions

Four of the most significant factors affecting the demand for coal in the Powder River Basin and southern Wyoming are: 1) electricity demand growth rate, 2) transportation costs, 3) mining costs and 4) developments in coal-based synthetic fuels. Other factors that presently affect, or could affect, the future demand for coal from the two regions include: the implementation of sulfur scrubbing requirements, the effect of reclamation requirements, levels of severance taxes and royalty rates, the rate of industrial boiler conversion from oil and gas to coal, the future of nuclear power, the cost of oil and gas, the possibility of new transportation

*Further discussion of regional market factors can be found in Chapter 4 (OTA, 1981).

**In Wyoming, competition from undeveloped state and fee coal is not a major factor affecting federal lease development because very little of this coal can be developed without federal coal. In the Montana Powder River Basin, however, Indian coal can be a source of competition for the development of federal leases.

networks that would open an export market for steam coal in Asia, and competition from coal produced in neighboring states such as Colorado and Utah.

Table 5.1 summarizes the effect of these different factors on the demand for coal from southern Wyoming and the Powder River Basin.* The Table identifies which conditions in the current market stimulates an increase in demand and which a decrease in demand. The Table also indicates any trends or developments that could affect Wyoming coal markets in the future. The overall picture that emerges from this table is that the factors adversely affecting the marketability of Wyoming coal appear stronger than those improving its marketability. The following developments could alter this situation: increased demand for electricity, reduction in transportation costs brought about by slurry pipeline use, commercial development of coal-based synthetic fuels, continued increase in the cost of oil and gas, and new export markets in Asia. Changes in electrical growth rate, transportation costs, and synfuel development are likely to have the greatest significance in changing the market demand for Powder River Basin and southern Wyoming coal. Such changes are not likely to have a substantial impact on Wyoming coal development within the next ten years.

Demand and Production Projections**

Over the last eight years, numerous studies have projected various production scenarios for the Powder River Basin. Table 5.2 summarizes

*The various factors in this table are discussed in more detail in Chapter 4 (OTA, 1981).

**Demand and production projections for the Powder River Basin, including some projections now shown here, are further discussed in the PRB Case Study, Chapter 6 (OTA, 1981).

TABLE 5-1

FACTORS AFFECTING MARKETABILITY OF POWDER RIVER BASIN AND SOUTH WYOMING COAL

Factor	Markets Increase When Factor Is:	Markets Decrease When Factor Is:	Current Market Situation in West	Current or Probable Trends (1980-1990)
USER NEEDS				
Utilities				
Electrical Growth Rate	High (>3%)	Low (<3%)	Low	Low - moderate
SO_2 Emissions Standards	1970 NSPS, Limits on total emissions	1979 NSPS OR no emissions limits	Current standards reduce demand compared to 1970 NSPS.	Amendments to Clean Air Act could change situation either way.
Competing Energy Sources				
Cost of Oil & Gas	High	Low	High	Higher
Nuclear Power Growth	Low	High	Low (in West)	Low (in Western coal's market area)
Industrial				
Steel Production	High	Low	Low	Low
Industrial Boiler Conversions	High	Low	Low	Low - moderate
Synthetic Fuels Development	High	Low	Low	Low - moderate
Foreign Export	High	Low	Low	Possible Increase
COSTS****				
Mine (FOB) cost per million Btu			Overall:* Low (Northern Plains)	Little change
Equipment Cost, Operation & Maintenance	Low	High	Moderate	Little change
Labor	Low	High	Low - moderate	Little change
Reclamation	Low	High	Low	Little change**
Health & Safety	Low	High	Low - surface mines High - underground mines	Little change Little change
Royalty Rates	Low	High	Low - existing leases High - new leases	Increases as existing leases come up for adjustment
Severance Taxes	Low	High	Low - High	Some increase or decrease at state level is possible
Delivered Cost				
Transportation	Low	High	Low (mine-mouth plants) High (export)	Additional increases likely with rail deregulation and increased fuel costs. Possible decreases in some localities with slurry pipelines
Technologies for Clean Burning of Coal (cost)	High***	Low	Moderate - High	Decreases possible through increased experience and technological improvements
INSTITUTIONAL CONSTRAINTS AT MINE	Low	High	Insitutional constraints are highly site specific	

* Relative to the cost of midwestern coal.

** Little change in reclamation costs is likely in the West, but proposed amendments to the Surface Mining Control and Reclamation Act that would give states more flexibility in setting reclamation standards could decrease markets for midwestern coal because the relatively high reclamation costs in the midwest resulting from enforcement of the Act might be reduced.

*** High costs for technologies promoting clean burning of coal (coal cleaning, flue gas desulfurization and fluidized bed combustion) favor western coal because of its generally low sulfur and ash content. Decreases in costs favor increased use of high sulfur midwestern coal. Reliability of these technologies is also an important factor, with low reliability favoring western coal and high reliability favoring midwestern coal.

**** For utilities and industrial boiler users the essential cost factors are delivered price and the cost of technologies for clean burning of coal. For the steel industry cost comparisons are restricted to coals that have characteristics that are suitable for making coke.

TABLE 5.2 POWDER RIVER BASIN:
SUMMARY OF "MOST LIKELY" PRODUCTION PROJECTIONS IN 1985 AND 1990

YEAR PROJ. MADE	SOURCE OF PROJ.	TYPE[1]	1985 MT	1985 WY	1985 COMBINED	1990 MY	1990 WY	1990 COMBINED
1972	(1)	M	—	—	—	—	—	426.0
1974	(2)	P	—	122.0	—	—	150.0	—
1976	(3)	M	84.6	74.5	159.1	123.1	93.7	216.8
1976	(4)	M	38.0	85.0	123.0	—	—	—
1978	(5)	M	—	—	204.6-[2] 305.6	—	—	396.1-[2] 529.0
1979	(6)	M	77.4	60.2	137.6	280.3	137.4	417.7
1979	(7),(8)	P	83.2	169.6	252.8	88.0	174.3	262.3
1980	(9)	M	63.0	95.6	158.6	117.1	158.1	275.2
1980	(10)	M	39.0	109.0	148.0	—	—	—
1980	(11)	P	—	119.6	—	—	133.3	—
1980	(12)	P	63.1	—	—	72.4	—	—
1980	(13)	P	48.9	127.5[3]	176.4	66.4	145.2[3]	211.6
1980	(14)	P	55.1	114.2	169.3	85.5	140.4	225.9

[1] M = Projection bases on computer or other model
P = Projection based on mine proposals

[2] Table 2 and 10 of report gives different sets of figures for 1985 and 1990.

[3] Numbers modified slightly from original projections made by Sebesta (1980) based on Task Force review.

Sources of Projections:

(1) Persse and Willard (1972)
(2) BLM (1974)
(3) Harza Engineering Company (1976)
(4) Mountain University Coal Demand Study Team (1976)
(5) Department of Energy (1978)
(6) Department of Energy (1979)
(7) BLM (1979b)
(8) USGS (1980a)
(9) Department of Energy (1980)
(10) Energy and Environmental Analysis (as cited in Coal Week)
(11) Glass (1980)
(12) Unpublished projections for Northern Powder River Basin EIS, September 23, 1980
(13) Sebesta (1980)
(14) ICF (1980, 6)

fourteen of these production projections for the Powder River Basin and Table 5.3 summarizes similar data for southern Wyoming.

These tables present two different kinds of projections. Most are based on models that assume certain conditions in coal markets. Other projections are based on production commitments by contract and potential production based on specific mine proposals.

The five most recent projections based on modeling and production plans for the Wyoming Powder River Basin made in 1980 (see Table 5.2) range from 95.6 to 127.55 million tons in 1985 and 133.3 to 158.1 million tons in 1990. In 1979, 45.9 million tons of coal were produced in the Wyoming Powder River Basin. Of this amount, 42.4 tons were mined on federal leases. Projections for the Montana Powder River Basin range from 39.0 to 63.1 million tons in 1985 and 66.4 to 117.1 million tons in 1990. In 1979, the Montana Powder River Basin produced 32.2 million tons of coal, of which 27.2 million tons were from mines with federal leases. Projections for southern Wyoming are for 37.2 to 49.1 million tons in 1985 and 42.2 to 57.9 million tons in 1990. In 1979, southern Wyoming produced 25.3 million tons. None of these include significant amounts (more than 10 million tons) of production for synthetic fuels plants.

The last projections shown on Tables 5.2 and 5.3 (Sebesta 1980) were prepared specifically for OTA's Wyoming Task Force.* These were developed by compiling information on coal going to existing power plants and to power plants planned for construction between now and 1991 that will use Wyoming coal. Ratios of contract utility coal to spot market coal, and total

*The projection used the data base developed by the EPA-USDA Coal Use and Development Project, located at Colorado State University, Fort Collins, CO.

TABLE 5.3 SOUTHCENTRAL AND SOUTHWEST WYOMING:
SUMMARY OF "MOST LIKELY" PRODUCTION PROJECTIONS IN 1985 AND 1990

YEAR PROJ. MADE	SOURCE OF PROJ.	TYPE[1]	1985 SC	1985 SW	1985 COMBINED	1990 SC	1990 SW	1990 COMBINED
1978	(1)	M	—	—	97.1	—	—	129.1
1978	(2), (3)	P	19.2	31.2	50.4	31.2	17.8	49.0
1979	(4)	M	—	—	59.2	—	—	85.6
1979	(5)	P	16.8	—	—	—	—	—
1980	(6)	M	—	—	49.8	—	—	57.9
1980	(7)	M	—	—	40.0[2/]	—	—	—
1980	(8)	P	14.4	22.8	37.2	18.9	23.3	42.2
1980	(9)	P	—	—	38.4	—	—	50.8

1
M = Projection based on computer model
P = Projection based on mine proposal

2
Also includes northwest Colorado.

Sources of Projections:

(1) Department of Energy (1978)
(2) BLM (1978a)
(3) BLM (1978b)
(4) Department of Energy (1979)
(5) Glass and Roberts (1979)
(6) Department of Energy (1980)
(7) Energy and Environmental Analysis (as cited in Coal Week)
(8) Glass (1980)
(9) Sebesta (1980), as modified by Wyoming Task Force.

utility coal to industrial coal, were then used to estimate total demand for coal mined in the Powder River Basin and southern Wyoming.

The Wyoming Task Force reviewed the various projections and concluded that production projections made by Glass (1980) and OTA (Sebesta 1980) were more likely to be realistic than the various modeling projections identified in Table 5.2. The Department of Energy's projections, which are used as a basis for setting leasing targets in the federal coal management program, were singled out by the Task Force as being particularly problematic because small changes in assumptions used in the model can result in large differences in allocation of production to different coal regions.*

Projections by OTA and Glass are very close in 1985 for southern Wyoming (38.4 vs. 40.0 million tons), but OTA's projections are about 10 million tons higher than Glass's projections for 1990 in southern Wyoming and for both 1985 and 1990 in the Wyoming Powder River Basin. The apparent reason for these differences is that the OTA projections were generally based on the nameplate capacity for a proposed plant or on the historical use of coal for an existing plant. Thus, these projections do not entirely reflect the fact that utility coal deliveries from the Powder River Basin are presently running considerably below maximum amounts specified in contracts and are likely to do so for the next few years primarily because of reduced demand for electricity and the effects of the economic recession throughout the country. The Task Force selected the Glass projections as identifying the most likely level of demand for the next ten years (120

*For a more thorough discussion of these and other problems with the DOE model, see ICF, 1980b.

**See Chapter 6 (OTA, 1981).

million tons in 1985 for the Powder River Basin and 40 million tons in southern Wyoming) and the OTA projections as representing possible high levels of demand. The Task Force also recognized that conservation efforts and a continued decline in the growth rate for electricity could reduce demand below the Glass projections, although no consensus was reached on the likelihood of this occurring. In follow-up analysis of demand projections for the Powder River Basin, OTA identified the "most likely" range of demand to be from 200 to 226 million tons in 1990.*

Production Capacity of Developed Federal Leases

A separate study by OTA (Schmidt, Porte and Silverman, 1980) evaluated production potential from developed Federal leases in the Powder River Basin and southern Wyoming. Tables 5.4 and 5.5 summarize information about developed leases in the two regions and includes mine capacities planned by the lessees in 1991. Additional data on these leases and non-Federal mines can be found in Tables A.3.1 and A.3.2, Appendix 2.

Planned mine capacity in the Powder River Basin is 227 million tons/year. This is slightly higher than OTA's projected "likely" high demand in 1990. In contrast to the Powder River Basin, production potential from existing mines in southern Wyoming is slightly below the level projected by the Task Force in 1985, and 7 to 15 million tons less than the projected demand for 1990.

Two quite different pictures emerge from the comparison of coal markets in the Powder River Basin and in southern Wyoming now and over the next ten years. Planned capacity from developed leases alone in the Powder River

*See Chapter 6 (OTA, 1981).

TABLE 5.4

DEVELOPED FEDERAL LEASES IN THE POWDER RIVER BASIN:
PLANNED PRODUCTION CAPACITY AND OTHER DATA

MINE NAME	LESSEE	NUMBER OF FED. LEASES	FEDERAL LEASE RESERVES [1] (mt)	ACREAGE: TOTAL PERMITTED MINE PLAN	ACREAGE: LEASE	FIRST COAL SHIPPED	CUMULATIVE PRODUCTION 1976-1979 (mt)	PRODUCTION 1979 (mt)	REMAINING MINE LIFE [2]	1991 Mine Design Capacity
(Montana)										
Rosebud	Western Energy Co.	5	HM	6,198	8,227	1920's	41.3	11.7	40 Years	19.8
Big Sky	Peabody Coal Co.	1	LM	2,351	4,307	1969	9.3	2.5	38 Years	4.6
Spring Creek	Spring Creek Coal Co.	1	L	3,016	2,347	1980	0.0	0.0	25 Years	10.0
West Decker	Decker Coal Co.	1	HM	3,137	4,961	1972	55.7	7.1	21 Years	10.4
East Decker	Decker Coal Co.	4	L	4,378	9,410	1978	5.9	5.9	27+ Years	7.6
MONTANA TOTALS		12	812	19,080	29,252		112.2	27.2		52.4
(Wyoming)										
Buckskin	Shell Oil Co.	1	LM	1,467	600	1981	0	0	16 Years	6.2
Rawhide	Carter Mining Co.	1	L	7,393	5,697	1977	7.2	3.6	26 Years	24.0
Eagle Butte	AMAX Coal Co.	1	L	4,304	3,520	1978	4.0	3.7	37 Years	25.0
Wyodak	Wyodak Resources	3	HM	3,240	1,880	1922	6.3	2.4	43 Years	5.0
Caballo	Carter Oil Co.	2	L	3,388	5,360	1979	1.4	1.3	44 Years	12.0
Belle Ayr	AMAX Coal Co.	1	L	6,280	2,360	1973	51.8	15.0	19 Years	11.0
Rojo Caballos	Mobil Oil Corp.	2	L	5,815	4,000	1983	0.0	0.0	27 Years	15.0
Cordero	Sunoco Energy Dev. Co.	1	L	8,232	6,560	1976	9.8	3.8	26 Years	24.0
Coal Creek	Atlantic Richfield Co.	1	L	9,545	5,806	1981	0.0	0.0	35 Years	12.0
Jacobs Ranch	Kerr-McGee Coal Co.	2	L	4,959	4,352	1978	6.5	4.7	22 Years	16.0
Black Thunder	Thunder Basin Coal Co.	2	L	7,560	5,884	1977	10.3	6.2	38 Years	20.5
Dave Johnston	Pacific Power & Light Co.	6	LM	14,305	9,742	1958	13.1	3.8	16 Years	3.8
WYOMING TOTALS		23	4,448	76,488	55,761		112.0	44.5		174.5
POWDER RIVER BASIN TOTALS:		35	5,260	95,568	85,043		224.2	71.7		226.9

[1] Non-federal reserves associated in Logical Mining Units with these Federal lease reserves add roughly 300 mt of recoverable reserves in both Montana and Wyoming (roughly 600 mt total added).

[2] As reported by the lessees in their mine plans.

Key to Reserve Ratings

S = small reserves (0-30 mt)
LM = low medium reserves (30-100 mt)
HM = high medium reserves (100-180 mt)
L = large reserves (180+ mt)
W/R = no surface reserves

TABLE 5.5

DEVELOPED FEDERAL LEASES IN SOUTHERN WYOMING:
PLANNED PRODUCTION CAPACITY AND OTHER DATA

Mine Name	Lessee	No. of Federal Leases	Federal Lease Reserves	Lease Acres	Cumulative Federal Production to 1979 (mt)	Total Production 1979 (mt)	Planned Mine Capacity 1991
Medicine Bow	Medicine Bow Coal Co.	2	S	2,568	3.2	2.3	3.3
Rosebud	Rosebud Coal Sales	2	S	1,403	4.4	2.4	3.4
Seminoe No. 1	Arch Mineral	1	S	6,315	6.9	2.3	-
Seminoe No. 2	Arch Mineral	7	S	3,677	16.2	2.9	-
Vanguard No. 2	Energy Development Co.	1	S	8,683	4.1	0.9	1.0
Carbon County	Carbon County Coal Co.	3	HM	1,280	0	0.1	1.5
Black Butte	Black Butte Coal Co.	1	LM	14,902	0	1.2	10.0
Jim Bridger	Pacific Power & Light	3	L	8,436	15.3	5.7	7.9
Stansbury	Stansbury Coal Co.	1	S	1,645	0.7	0.3	1.3
Elkol-Sorenson	Kemmerer Coal Co.	2	S	3,648	1.7	4.3	5.0
Skull Point	FMC Corp.	2	S	3,201	0	0.8	1.5
Total		25	591.7	55,758	52.5	23.2	34.9

Key to Reserve Rating
S - small reserves (0 - 30 mt)
LM - low medium reserves (30 - 100 mt)
HM - high medium reserves (100 - 180 mt)
L - large reserves (180+ mt)

Basin is probably sufficient to meet the likely range of demand over the next ten years, even if no undeveloped Fedeal leases and non-Federal mines produce coal. Since other mines are planned to produce coal in 1990, it is clear that production over the next ten years will be demand constrained in the Powder River Basin. In southern Wyoming, on the other hand, it appears that in the next ten years demand will exceed the production available from existing mines in the region. The implications of these two different market situations are examined in more detail in the next chapter.

CHAPTER 6. DEVELOPMENT AND PRODUCTION PROSPECTS OF UNDEVELOPED FEDERAL COAL LEASE AND PRLAS BLOCKS IN THE POWDER RIVER BASIN AND SOUTHERN WYOMING

This chapter summarizes the results of the Wyoming Task Force assessment of the development and production prospects for undeveloped federal coal lease and PRLA blocks in the Powder River Basin and southern Wyoming, and additional follow-up and analysis conducted by OTA after the Task Force meeting.

OTA cannot overemphasize the importance of the Wyoming Task Force* in providing assistance in assessing the development and production prospects of the undeveloped federal coal leases in the Powder River Basin and southern Wyoming. Available lease specific information was often insufficient to screen each lease block in a comprehensive manner, and the regional factors affecting lease development were too complex for any single individual to evaluate fully their importance for each lease block. The Task Force participants represented state and Federal agencies with responsibilities related to coal development, companies with leaseholdings in the region, and agricultural and environmental groups. The collective knowledge and experience of the Task Force was used to: 1) examine critically the issues discussed in the preceding chapters of this report, 2) refine the criteria used for lease evaluation, and 3) apply these criteria to individual lease blocks.

OTA does not consider the analysis in this chapter to constitute predictions concerning how or when a specific federal lease block or PRLA block will actually be developed. A number of factors could lead to a

*Appendix 5 includes the agenda and list of participants in the Wyoming Task Force Meeting.

a different outcome for an individual tract than is suggested in this report. Judgments concerning PRLA blocks have an even higher level of uncertainty. Nonetheless, the Task Force conclusions on individual lease and PRLA blocks, especially those pertaining to acreages, reserves, and the general prospects for development can be considered reasonably accurate within the 10 to 15 year time frame of the analysis. Factors that could result in different outcomes for individual lease blocks than those suggested by the Task Force are discussed in more detail later in this chapter.

Overview of the Task Force Results and OTA Follow-Up

Tables 6.1 and 6.2 summarize the results of the evaluation of the development potential and production prospects for undeveloped leases and PRLAs in the Powder River Basin and Table 6.3 summarizes this information for southern Wyoming. A more detailed summary of the results of applying the screening criteria can be found in Tables A.2.1 to A.2.4 in Appendix 2 (Wyoming) and Table A.3.2 in Appendix 4 (Montana). These tables also show where Task Force ratings have been modified by OTA as a result of later follow-up. The reasons for changes in Task Force ratings (if made) and additional information about individual lease blocks can be found in the undeveloped lease and PRLA block summary sheets in Appendix 2.

Powder River Basin* Fourteen undeveloped lease blocks containing 26 leases and 2.9 billion tons of reserves have favorable development potential (Table 6.1), but due to weak markets, only three (Antelope, North Antelope

*Further analysis of development potential and production prospects of leases and PRLAs in the Powder River Basin can be found in Chapter 6 (OTA, 1981).

TABLE 6.1

Production Prospects for Undeveloped Leases: Powder River Coal Basin

Development potential	Lessee[a]	Number of Leases	Location by county[1]	Acres	Capacity[2] (million tons)	Reserves (billion tons)	Production prospects[3] 1986	1991
Leases with favorable development potential								
Antelope	Resource Development Co.	3	Converse	4,817	8.0 (12.0)	L	Favorable(a)	Favorable
N. Antelope	N. Antelope Coal	1	Campbell	320	5.0	S	Favorable(a)	Favorable
South Rawhide	Carter Mining	1	Campbell	4,782	12.0	L	Favorable(b)	Favorable
Rochelle	Peabody Coal	2	Campbell	8,821	6.0 (11.0)	L	Unfavorable	Favorable(e)
Dry Fork	Cities Service	3	Campbell	3,580	8.0 (15.0)	L	Uncertain	Uncertain
E. Gilette Fed.(h)	Kerr-McGee Co.	3	Campbell	4,343	15.0	L	Uncertain	Uncertain
N. Rochelle	Shell Oil Co.	1	Campbell	2,000	8.0	L	Uncertain	Uncertain
CX Ranch	Consolidation Coal	1	Big Horn, Mt	674	8.0	S	Uncertain	Uncertain
CX Ranch	Peter Kiewit Sons, Inc.	1	Big Horn, Mt	524	4.0	S	Unfavorable	Uncertain
Wildcat	Gulf Oil Co.	1	Campbell	1,571	7.0 (10.0)	L	Unfavorable	Uncertain(e,g)
Lake DeSmet(e)	Texaco	5	Johnson	9,417	— (20.0)	L	Unfavorable	Unfavorable(e,g)
Phillips Creek (1)(c)	PPL	4	Converse	4,039	—	S	Unfavorable	Unfavorable
Totals		26		44,888	81 (120)	3.3		
Leases with uncertain development potential								
Bass Trust(f)	R.D. Bass Trust Estate	1	Sheridan	20,701	—	L	Unfavorable	Unfavorable
Belco(f, h)	Belco Petroleum	1	Johnson	4,551	—	L	Unfavorable	Unfavorable
Gulf (1) & (2)(f)	Gulf Oil Corp.	3	Sheridan	4,366	—	HM	Unfavorable	Unfavorable
East Wyodak(d)	Peabody Coal	1	Campbell	2,560	— (7.0)	LM	Unfavorable	Unfavorable(e,g)
Pearl	Shell Oil Corp.	1	Big Horn, Mt	541	— (2.0)	LM	Unfavorable	Unfavorable
Totals		7		32,719	— (9.0)	0.7		

Table 6.1 (continued)

Leases with unfavorable development potential								
Armstrong(h)	Big Horn Coal	1	Sheridan	80	—	S	Unfavorable	Unfavorable
Blue Diamond	Wyodak Resources	1	Campbell	40	—	S	Unfavorable	Unfavorable
Gulf (3)(h)	Gulf Oil Corp.	1	Campbell	756	—	S	Unfavorable	Unfavorable
Phillips Creek (2)	PPL	1	Converse	40	—	S	Unfavorable	Unfavorable
Totals		4		916	—	< 0.01		

[a]Counties are in Wyoming unless otherwise noted.
[b]Numbers without parentheses show capacities for 1991; numbers in parentheses indicate capacities after 1991.
[c]Where footnote appears under "development potential" it is relevant to the development of the lease. Footnotes under "production prospects" are relevant to production prospects only.
[d]See the Working Lease List, app. B, for a listing of both parent companies and subsidiaries.

Key to production prospects:
(a) coal already under contract
(b) coal may be combined with contracted production of another mine owned by the same company
(c) plans to incorporate into existing mine plan
(d) may be incorporated with PRLA to form LMU
(e) production contingent on synfuel development
(f) production dependent on in situ gasification
(g) production contingent on onsite steam electric plant
(h) may be traded under provisions of Public Law 95-554

Key to reserve ranking:
S = small reserves (zero to 30 million tons)
LM = low to medium reserves (30 million to 100 million tons)
HM = high to medium reserves (100 million to 180 million tons)
L = large reserves (over 180 million tons)

SOURCE: Office of Technology Assessment.

TABLE 6.2

PRODUCTION PROSPECTS FOR PRLA's: POWDER RIVER COAL BASIN

Development Prospects	Owner/Parent Company	Number of PRLA's	County	Acreage	Reserves	Production Prospects (1998)
PRLA's with Favorable Development Potential:						
Peabody (P2)	Peabody Coal Co.	1	Campbell	520	S	Favorable (a)
Wold-Jenkins (5)	Wold-Jenkins	1	Campbell	80	S	Favorable (a)
North Antelope (1)	North Antelope Coal	2	Campbell	240	S	Favorable (a)
Totals		4		840	15	
PRLA's with Uncertain Development Potential:						
Peabody (P4)	Peabody Coal Co.	1	Converse	835	LM (4.8)[4]	Uncertain (b,e)
Consol (1)	Consolidation Coal, Co.	3	Campbell	5,610	L (7.0)	Uncertain (b,e,)
Consol (2)	Consolidation Coal Co.	2	Campbell	8,534	L (8.5)	Uncertain (b,e,)
North Antelope (2)	North Antelope Coal	2	Campbell & Converse	1,240	S	Uncertain (d)
Aroe (1)	ARCO	1	Campbell	357	S	Uncertain (d)
Aroe (2)	ARCO	2	Campbell	240	S	Uncertain (d)
Peabody (P3)	Peabody Coal Co.	4	Campbell	2,200	LM	Uncertain (d)
Western Fuels (1) (Stevens North)	Western Fuels Assoc.	3	Converse	8,864	MM[1]	Uncertain (d)
Dixie (2)	Dixie Natural Resources	1	Converse	2,276	LM	Uncertain (c,e)
Thunderbird	El Paso Coal Co.	12	Campbell & Johnson	23,928	S[2], L[3]	Unfavorable (f)
Wold-Jenkins (1-4)	Wold-Jenkins	13	Campbell & Johnson	20,896	NSR	Unfavorable (f)
Totals		44		78,580	1424	
PRLA's with Unfavorable Development Potential:						
Consol (3)	Consolidation Coal Co.	2	Campbell	3,640	LM	Unfavorable
Dixie (1)	Dixie Natural Resources	1	Converse	800	NSR	Unfavorable
Peabody (P1)	Peabody Coal Co.	4	Campbell	3,380	S	Unfavorable
Peabody (P5)	Peabody Coal Co.	2	Converse	3,628	S	Unfavorable
(Dull Center) Western Fuels (2)	Western Fuels Assoc.	1	Converse	4,352	NSR	Unfavorable (f)
Totals		10		15,808	127	

Key to Production Prospects:

a = favorable if integrated into existing LMU (in which case production of total LMU will count toward diligence requirements).

b = production contingent on on-site development (synfuels and/or steam).

c = possible procedural irregularities and/or overlapping mining claims

d = favorable if issued (possible procedural irregularities and/or overlapping mining claims) and if integrated into existing LMU.

e = possibility exists for local industrial use of the coal.

f = possibilities exist for in-situ gasification

[1]Reserves with stripping ratio less than 3.5 are probably small.

[2]Small surface reserves.

[3]Large underground reserves.

[4]number in parenthesis indicates potential mine capacity, if lease is issued

Key to Reserve Ratings:

S = small reserves (0-30 mt)

LM = low medium reserves (30-100 mt)

MM = high medium reserves (100-180 mt)

L = large reserves (180+ mt)

NSR = No surface reserves

TABLE 6.3

PRODUCTION PROSPECTS FOR UNDEVELOPED LEASES AND PRLA'S: SOUTHERN WYOMING

Development Potential*	Lease/PRLA Holder	Number of Leases/ PRLAs	Location by County	Acres	Capacity (mt)	Federal Reserves (mt)	Production Prospects* 1986	1991 (1994)**
Leases with Favorable Development Potential								
Hanna South	Ark Land	1	Carbon	640	0.6	S	Favorable	Favorable
Cherokee	NERCO	4	Carbon and Sweetwater	4271	6.0	LM	Unfavorable	Uncertain (a)
South Haystack	Cumberland Coal	1	Uinta	1408	3.0	LM	Favorable	Favorable
Long Canyon	SunEDCo	1	Sweetwater	14680	2.0	LM	Favorable	Favorable
North Block-	Kemmerer Coal Co.	4	Lincoln	2632	1.5	S	Favorable	Favorable
Twin Creek	Kemmerer Coal Co.	1	Lincoln	306	2.5	S	Unfavorable	Favorable (b)
		12		23937	15.6	241.1		
Leases with Unfavorable Development Potential								
North-North Block (c)	Kemmerer Coal Co.	1	Lincoln	1247	-	S	Unfavorable	Unfavorable
Peabody (2)	Peabody Coal Co.	2	Sweetwater	2480	-	S	Unfavorable	Unfavorable
Rainbow #8	Sweetwater Resources	1	Sweetwater	1752	-	S	Unfavorable	Unfavorable
Cottonwood	Connotton Land Co.	1	Sublette	160	-	S	Unfavorable	Unfavorable
Deadman	Connotton Land Co.	1	Lincoln	240	-	S	Unfavorable	Unfavorable
Granite Creek (d)	Granite Creek Coal Co.	1	Teton	280	-	S	Unfavorable	Unfavorable
Kowlok	Northwest Resources	1	Hot Springs	120	-	S	Unfavorable	Unfavorable
Western Nuclear	Western Nuclear	1	Hot Springs	80	-	S	Unfavorable	Unfavorable
		9		6359		15.2		

TABLE 6.3 (Cont)

PRODUCTION PROSPECTS FOR UNDEVELOPED LEASES AND PRLA'S: SOUTHERN WYOMING

Development Potential*	Lease/PRLA Holder	Number of Leases/ PRLAs	Location by County	Acres	Capacity (mt)	Federal Reserves (mt)	Production Prospects 1986	1991 (1994)*
PRLAs with Favorable Development Potential								
Bean Springs	Ark Land Co.	4	Sweetwater	8202	1.0	LM (e)	-	Unfavorable
PRLAs with Unfavorable Development Potential								
Kemmerer (1)	Kemmerer Coal Co.	1	Carbon	5010	-	S	-	Unfavorable
Kemmerer (2)	Kemmerer Coal Co.	1	Carbon	4816	-	S	-	Unfavorable
Kemmerer (3)	Kemmerer Coal Co.	1	Carbon	4510	-	S	-	Unfavorable
Kemmerer (4)	Kemmerer Coal Co.	1	Carbon	5079	-	S	-	Unfavorable
Kemmerer (5)	Kemmerer Coal Co.	2	Carbon	4515	-	S	-	Unfavorable
Kemmerer (6)	Kemmerer Coal Co.	1	Carbon	4881	-	S	-	Unfavorable
Rosebud	Rosebud Coal Sales	2	Sweetwater	3028	-	S	-	Unfavorable
Salt Wells	Peabody Coal Co.	1	Sweetwater	2880	-	S	-	Unfavorable
		10		34719		126.7		

TABLE 6.3 (Cont)

PRODUCTION PROSPECTS FOR UNDEVELOPED LEASES AND PRLA'S: SOUTHERN WYOMING

* Where footnote appears under "Development Potential" it is relevant to the development of the lease. Footnotes under "Production Prospects" are relevant to production prospects only.

** 1991 = leases, 1994 = PRLA'S.

Footnotes:

(a) Production contingent on on-site development

(b) Lease will be mined as part of North Block mine

(c) Lease could possibly be integrated into North Block LMU

(d) Was in the process of being relinquished in late 1980

(e) Reserve included in total for PRLA'S with unfavorable development potential to protect confidentiality of information.

Key to Reserve Ranking

S = small reserves (0-30mmt)
LM = low medium reserves (30-100 mmt)
HM = high medium reserves (100-180 mmt)
L+ = large reserves (180+ mmt)

and South Rawhide) were judged to have favorable production prospects in 1986. In 1991, only one other lease (Rochelle) was given favorable production prospects, while most of the others have uncertain production prospects. This is because developed leases in 1991 alone will probably have sufficient capacity to meet the likely range of demand for coal from the region (see previous chapter), so, although a number of these lease blocks are likely to produce coal in 1991, it is impossible to predict which ones will capture a share of the market.

Six lease blocks containing seven leases and 710 million tons have uncertain development potential, with development of four of these contingent on in-situ gasification (Bass Trust, Gulf (1) and (2) and Belco). The other two, East Wyodak and Pearl have unfavorable production prospects in 1991, but could possibly support mines after that period if they are not cancelled because of failure to meet diligence requirements.* Four leases containing 50 million tons of reserves have unfavorable development potential in the Powder River Basin.

Only three PRLA blocks, containing 14.9 million tons of reserves, were judged by OTA to have favorable development potential and in all three cases production is contingent on integration into an existing or proposed federal mine (see Table 6.2). None of these PRLAs would contribute significantly to production capacity of the region. The majority of PRLA blocks (12 out of 22) containing 1.4 billion tons of reserves in the Powder River Basin were

*A more detailed analysis of the ability of existing leases to meet diligence requirements can be found in Chapter 5 (OTA, 1981). It is possible that these leases would not be cancelled since the Department of the Interior is reported to be considering eliminating the 10-year diligence requirements (Coal Week May 18, 1981).

rated as having uncertain development potential. Only three of these (Consol (1) and (2) and Peabody (P4)) have the potential for adding significant production capacity to the region and all three of these depend on on-site development because of the low heat content and high stripping ratios and have possible impediments to lease issuance. (Table 6.4 summarizes the factors that could affect issuance of preference right lease applications with favorable and uncertain development prospects).

Five of the PRLAs with uncertain development potential would have to be integrated into existing or proposed mining operations to produce coal, and in each of these blocks there are possible impediments to lease issuance (see Table 6.4). Five more blocks (Thunderbird and Wold-Jenkins (1) to (4)) depend on in-situ gasification for development and were rated as having unfavorable production prospects in 1994 due to the experimental nature of this technology. All other PRLA blocks with uncertain development potential were given uncertain production prospects in 1994 due to uncertainties over lease issuance and, in the case of the three blocks that could support new mines, the rate of synthetic fuels development in the region. Five PRLA blocks containing 126.5 million tons of reserves were rated as having unfavorable development potential, and consequently unfavorable production prospects in 1994.

Southern Wyoming. Six undeveloped lease blocks containing 12 leases and 241.1 million tons of reserves were rated as having favorble development potential and all of these have favorable production prospects by 1986 or 1991 except for NERCO's Cherokee block which has uncertain production prospects in 1991 because production is contingent on on-site development (see Table 6.3). Eight lease blocks containing 15.2 million tons of

TABLE 6.4 - FACTORS AFFECTING ISSUANCE OF PRLAs WITH FAVORABLE OR UNCERTAIN DEVELOPMENT PROSPECTS

Block Characteristics	No Known Impediments to Lease Issuance	Possible Impediments to Lease Issuance		
		Mining Claims	Procedural Irregularities[1]	Both
Meet reserve and other screening criteria	Bean Springs	Consol(1)	Peabody (P4)	Consol(2)
Small reserves, but favorable development prospects if integrated into existing LMU	Peabody (P2) Wold-Jenkins(5) N. Antelope(1)		Peabody(P3) N. Antelope(2)	Arco(1) Arco(2) Western Fuels (1)
Doesn't meet reserve criteria, but possibility of development for local use		Dixie(2)		
Reserves only suitable for in-situ gasification	Thunderbird Wold-Jenkins (1) - (4)			

[1] Examples of procedural irregularities are: initial showing of commercial quantities not timely filed, and existance and workability of coal known before issuance of a prospecting permit (such as abandoned underground mine workings within the permit boundaries). See Chapter 2 for more detailed discussion of this.

reserves were rated as having uncertain or unfavorable development potential and all were rated as having unfavorable production prospects in 1991.* One PRLA block in southern Wyoming (Bean Springs) was judged to have favorable development potential, but production prospects were considered to be unfavorable in 1994 because of the long distance from existing rail lines, and the fact that the potential production levels (1.0 million tons) would not justify the expense of constructing a rail line. The other eight PRLA blocks in southern Wyoming have unfavorable development potential, primarily because they have small reserves and are mostly distant from existing rail lines.

Reserves in Different Development Categories. Table 6.5 summarizes the relationship between acreage and reserves in the various categories of development potential. In the Powder River Basin, developed leases contain a little more than half the acreage under lease (52%) and the 5.3 billion tons of reserves in these leases represent 59% of lease reserves in the region. Undeveloped leases with favorable development potential contain 27% of the leased acreage and 32% of the lease reserves. Thus, developed leases and undeveloped leases with favorable development potential combined contain just over 90% of the lease reserves. Leases with uncertain and unfavorable development potential contain 21% of lease acreage, but only 9% of the lease reserves in the Powder River Basin. Most of the acreage under PRLA in the Powder River Basin has uncertain development potential (82%) while these PRLAs contain an even higher percentage of reserves (91%).

*Of these eight, all have unfavorable development potential except North-North Block which has uncertain development potential. Reserves in this block are included with totals for blocks with unfavorable development potential to protect confidentiality of information.

TABLE 6.5

COMPARISON OF ACREAGE AND FEDERAL RESERVES IN LEASES AND PRLA'S
BY CATEGORY OF DEVELOPMENT POTENTIAL

		Powder River Basin				Southern Wyoming			
		Number of Blocks	Number of Leases	Acres	Reserves (mt)	Number of Blocks	Number of Leases	Acres	Reserves (mt)
Developed Leases	MT	5	12	29,252	812				
	WY	12	23	55,761	4,448				
		17 (41%)*	35 (47%)*	85,013 (52%)*	5,260 (59%)*	11 (44%)*	25 (54%)	55,758 (64%)	591.7 (70%)
Undeveloped Leases, Favorable Development Potential	MT	2	2	1,198	- 1/				
	WY	10	24	43,789	- 1/				
		12 (29%)	26 (35%)	44,987 (27%)	2,900 (32%)	6 (24%)	12 (26%)	23,937 (29%)	241.1 (28%)
Undeveloped Leases Uncertain Development Potential	MT	1	1	541	- 1/				
	WY	5	6	32,278	- 1/				
		6 (15%)	7 (9%)	32,819 (20%)	710 (8%)	1 (4%)	1 (2%)	1,247 (1%)	- 1/
Undeveloped Leases, Unfavorable Development Potential	MT 2/	2	2	160	- 1/				
	WY	4	4	916	- 1/				
		6 (15%)	6 (8%)	1,076 (1%)	50.5 (1%)	7 (28%)	8 (17%)	5,112 (6%)	15.2 (2%)
Total		41	74	163,895	8,920.5	25	46	86,054	848.0
PRLA'S, Favorable Development Potential 3/		3 (15%)	4 (7%)	840 (1%)	14.9 (1%)	1 (11%)	4 (29%)	8,202 (19%)	- 1/
PRLA'S Uncertain Development Potential		11 (57%)	44 (75%)	78,580 (82%)	1,423.9 (91%)	0	0	0	0
PRLA'S, Unfavorable Development Potential		5 (26%)	10 (17%)	15,808 (16%)	126.5 (8%)	8 (89%)	10 (61%)	34,719 (81%)	126.7
Total		19	58	95,228	1,565.3	9	14	42,921	126.7

TABLE 6.5 (cont'd.)

COMPARISON OF ACREAGE AND FEDERAL RESERVES IN LEASES AND PRLA'S
BY CATEGORY OF DEVELOPMENT POTENTIAL

*Number in parentheses is percent of total.

Footnotes:

1/ Not shown, to protect confidentiality of information, but reserves are included in totals.

2/ Undeveloped leases in the Bull Mountain and Yellowstone regions.

3/ All PRLA's in the Powder River Basin are located in Wyoming.

Compared to the Powder River Basin, developed leases in southern Wyoming have an even higher percentage of lease acreage (69%) and reserves (70%). Undeveloped leases with favorable development potential contain 29% of the lease acreage and 28% of lease reserves in the region, while undeveloped leases with uncertain and unfavorable development potential contain 7% of lease acreage and only 2% of lease reserves.

Prospects for On-Site Development of Leases. The development potential of federal coal reserves for onsite, coal-based synthetic fuels is uncertain. Approximately 50 million tons of coal on undeveloped federal leases and PRLAs is unsuitable for export, and consequently production hinges on onsite development.

In his energy message of July 15, 1979, President Carter established a goal of 1.0 to 1.5 million-barrels-per-day-equivalent of crude oil to be produced from coal-based synthetic fuels by 1990. In November, 1979 this goal was modified to 1.0 million-barrels-per-day by 1995 (Department of Energy 1980b). Realization of this goal would require about 30 coal-based synfuel plants. A recent study (SRI 1979) identified 25-33 potential areas where environmental and socioeconomic conflicts concerning the siting of synfuel facilities would be minimal. About half of these sites were located in the Illinois Basin.

The study identified only six or seven areas in the Northern Plains where environmental and socioeconomic conflicts over siting would not be significant and three or four such areas in the Four Corners/Rocky Mountain region. The SRI study identified only two areas in the Powder River Basin (one in Wyoming and another in Montana) with minimal siting conflicts, and no such areas in southern Wyoming. The other minimum conflict areas in the

Northern Plains are located in the Fort Union region of Montana, North Dakota and South Dakota.

The Wyoming Task Force essentially confirmed the results of this study without specifically evaluating it. The Task Force judged only one of the undeveloped leases associated with a synthetic fuels plan proposal as having favorable prospects for development by 1991. The longstanding proposal on the Rochelle lease for a coal gasification plant recently received funding from the Department of Energy for a feasibility study. The proposed location for this plant in Converse County is the only area in the Wyoming Powder River Basin identified in the SRI study as having minimal siting conflicts. The two other undeveloped lease blocks in the Powder River Basin that depend on onsite development (Lake DeSmet and Wildcat) were given unfavorable and uncertain production prospects respectively by 1991, and three PRLA blocks contingent on onsite development (Consol (1) and (2) and Peabody (P4)) were judged to have uncertain production prospects by 1994.*

Over the next 15 years, large blocks of federal and non-federal coal reserves will be available for onsite synthetic fuels development. Table 6.6 lists 14 blocks of federal and non-federal coal reserves sufficient to supply an onsite synthetic fuels plant producing at least 20,000 barrels per day of syncrude. Most of these reserves could support much higher levels of production. Five or six federal lease blocks in the Powder River Basin would probably be developed only for onsite use, and an additional seven

*Shortly before revisions were completed on this report additional reserve data developed by the USFWS for OTA (see Appendix 6) indicated that the East Wyodak Mine (rated as having uncertain development potential in this report has sufficient reserves to support an onsite synfuels plant. Ratings for development potential have not been changed, but this lease has been added to the list of leases for which there is potential production in the post 1991 period (see concluding section in this Chapter).

TABLE 6-6 - BLOCKS OF FEDERAL AND NON-FEDERAL COAL RESERVES
(at least 180 million tons)
SUFFICIENT TO SUPPLY A SYNTHETIC FUELS PLANT 1/

Coal Region	County	Block Name	Comments
Powder River Basin	Johnson	Lake DeSmet	Low BTU coal, suitable for on-site conversion.
		Mobil	Non-federal.
	Sheridan 2/	Carter (?)	State lease with about 4,500 acres strippable coal.
	Campbell	Wildcat	Low Btu, probably suitable only for on-site conversion.
		East Wyodak	Low Btu, high strip ratios, probably suitable only for on-site conversion as lease now stands.
		Rochelle	Coal reserves committed to proposed Panhandle Eastern Gasification Plant.
		Coal Creek	Existing mine >180M tons uncommitted reserves.
		Caballo	" "
		Rawhide	" "
		Cordero	" "
		Rojo Caballos	" "
		Black Thunder	" "
		Consol (1)	PRLA, with uncertain development prospec would probably need to be on-site.
		Consol (2)	" "
Green River Hams Fork	Carbon/ Sweetwater	Cherokee	Feasibility study underway.

1/ Unless otherwise indicated, blocks include primarily federal coal reserves.

2/ The Woodson PRLA in Sheridan County would probably have sufficient reserves to support a synfuel plant if combined with two adjacent state leases held by Carter Mining Co. However, this PRLA was judged by the Wyoming Task Force to have unfavorable development prospects.

blocks have a quantity of sufficient uncommitted reserves to supply a synthetic fuels plant. The Powder River Basin has two synthetic fuels projects in active planning stages (Panhandle Eastern's coal gasification plant, and the Hampshire Project which involves a 20,000 bpd gasoline plant) and two proposals in more preliminary stages involving Texaso's Lake DeSmet lease and Mobil's non-federal coal reserves in Johnson County. In southern Wyoming, the Cherokee Clean Fuels Project, associated with the Cherokee lease in Sweetwater County, is the only synfuels proposal in active planning stages.

Factors that Might Change Production Prospects of Individual Leases. Barring radical unforeseen changes in the national policy and market context in which coal development in the Powder River Basin and southern Wyoming takes place, the overall coal development picture described in this report should be reasonably accurate. However, judgments concerning the development and production prospects for individual lease blocks are less certain for several reasons:

1. Other alternatives may become more attractive. Judgments that a lease had favorable development and production prospects were often based on evidence that the leaseholder was actively preparing to develop the lease. However, such activities by a lessee are no guarantee that a lease will be developed. The Pearl lease in Montana, for example, had a final environmental impact statement completed before Shell Oil Co. dropped its plans for development. The lease does not have favorable development prospects according to OTA screening criteria, but apparently Shell had plans to develop the lease if negotiations with the Crow Tribe for the Young's Creek lease fell through. However, Shell dropped plans to develp

the Pearl lease once agreement was reached with the Crow Tribe. The Hanna South lease in Carbon county Wyoming has some similarities to the example given above. The lease does not meet the OTA reserve, sulfur or ash criteria, but mining of the lease is likely because equipment from the nearby Seminoe No. 2 Mine can be used, and the coal can be blended with higher quality coal from other sources to produce a marketable product.

2. More detailed evaluation of a lease that has favorable development prospects may result in a decision not to develop the lease. The Long Canyon lease is an example of this. At the time it was covered in an environmental impact statement (BLM 1978b), reserves had been determind on only a relatively small part of the lease. The Task Force gave this block favorable production prospects by 1991. However, shortly after the Task Force met, Coal Week (November 10, 1980) reported that SunEDCo was interested primarily in developing a surface mine, not an underground mine as was proposed in the EIS. Additional exploration has identified reserves that could possibly justify opening a surface mine, but a final decision to develop the lease has not been made.

3. Factors not known or considered by the Task Force at the time of evalution may change development or production prospects. For example, the Phillips Creek (2) block was judged to have unfavorable development prospects because of low reserves, low heat content, high ash and thin seams. A factor not considered by the Task Force was that the lease is adjacent to the operating Dave Johnston Mine which supplies an onsite power plant. Reserves at this mine are expected to be depleted by 1995, and the Phillips Creek (2) lease block has now been assigned to PP&L and is likely to be mined (after 1991) as part of the Dave Johnston Mine.

4. Resolution of uncertainties surrounding the applicability and enforcement of diligence requirements could change both development and production prospects for leases. Judgments made by the Task Force assumed enforcement of USDI diligence regulations for existing leases. If these regulations are held to be invalid as a result of litigation, or are modified to be less stringent, the diligent requirements may not be vigorously enforced. Under these circumstances, production from undeveloped leases in the Powder River Basin with favorable development prospects would be delayed until a stronger market exists for coal from the region. Similarly, leases with unfavorable development prospects could be retained in the hope that changing technology, economics, regulatory environment or leasing of new federal coal would alter their development prospects.

Mine Capacities vs Demand: 1991 and Beyond

This section examines the relationship between potential mine capacities from existing federal leases, and non-federal mines in the Powder River Basin and southern Wyoming to possible ranges of demand in 1990 and beyond.

Various factors must be considered in evaluating maximum production potential from a mine. First the reserves must be able to sustain production over a long enough period of time to return a profit on the capital investment in the mine. This time period is generally 30 to 40 years for a large mine, and a rough estimate of maximum production potential from a lease can be obtained by dividing the recoverable reserves by 30. Another factor to be considered is the capacity of coal load-out facilities at a mine. Generally, initial construction of capital facilities at a mine are designed to have a considerably higher capacity than initial planned

production levels. Thus, a mine may initially purchase equipment to mine five million tons a year, but construct load-out facilities to ship 15 million tons/year. This mine can increase production quite rapidly in response to increased demand to coal by adding new mining equipment, but once the capacity of the load-out facilities is reached, further increases in production require construction of new facilities which have longer lead times.

Tables 6.7 and 6.8 summarize information on planned and potential mine capacities in 1991 and beyond for the Wyoming and Montana Portions of the Powder River Basin and Table 6.9 summarizes this data according to category of development status, and differentiates capacities that are suitable for export and capacities that depend on on-site development in the region. Likely capacity, based on industry plans for the Powder River Basin is about 350 million tons in 1991. This exceeds OTA's likely high demand in 1990 (226 million tons) by over 120 million tons, and is about 30 million tons below "likely" high demand in 1995.* This estimation of likely capacity in 1991 is based primarily on industry plans as reflected in mine plans and OTA contacts with leaseholders. Given the large disparity between planned capacity and likely demand, many leaseholders might well let their schedules for developing capacity slip until there are higher levels of demand for

*Demand projections for 1995 have a considerable level of uncertainty but the DOE 1995 mid-level production goal (DOE, 1980a) has been chosen as a likely high. This is probably a generous estimation of the likely high since the DOE mid-level goal of 275 tons was 50 million tons higher than OTA likely high demand for that year. ICF's projected demand for 1995 for the Powder River Basin is 306 million tons (ICF 1980b). Since ICF's projection of 226 million tons for 1990 was considered by OTA to be the likely high demand, 306 million tons is probably a more likely level of demand, in which case planned capacity in 1991 would exceed this demand by about 45 million tons.

TABLE 6.7

Planned and Potential Mine Capacities in the Wyoming Powder River Basin:
1991 and Beyond

Developed Federal Mines 1/		Undeveloped Federal Leases 2/ Favorable Production Prospects 1991		Undeveloped Federal Leases 3/ Unfavorable Production Prospects 1991		Preference Right Lease Applications 4/		Nonfederal Mines 5/	
Mine Name	Mty	Mine/Lease Name	Mty	Mine/Lease Name	Mty	Block Name	Mty	Name	Mty
Buckskin	6.2	Antelope	12.0	Lake DeSmet 6/	20.0	Consol(1) 6/	7.0	Bighorn 7/	3.0
Rawhide	24.0	N. Antelope	5.0	East Wyodak 6/	7.0	Consol(2) 6/	8.5	Clovis 7/	5.0
Cabello	12.0	South Rawhide	12.0			Peabody(P4) 6/	4.0	Dutchman	1.0
Eagle Butte	25.0	Rochelle	11.0					Mobil (Johnson Co) 6/	11.0
Belle Ayr	11.0	Dry Fork	15.0					Whitney 8/	1.0
Wyodak	5.0	E.Gillette Fed.	15.0					Welch No. 1	1.0
Rojo Caballos	15.0	N. Rochelle	8.0						
Cordero	24.0	Wildcat 6/	10.0						
Coal Creek	12.0								
Jacobs Ranch	16.0								
Black Thunder	20.5								
Dave Johnston	3.8								
Total	174.5		88.0		27.0		19.5		22.0

TABLE 6.7 (Cont)

Planned and Potential Mine Capacities in the Wyoming Powder River Basin:
1990 and Beyond

Footnotes:

1/ Capacities planned by lessees in 1991. Note that Arco's Black Thunder Mine has reserves to support a 30 mty mine but received an air permit for only 20.5 mty. Note also that capacity for Rojo Caballos mine includes capacity for previously proposed Pronghorn Mine.

2/ Capacities planned by lessees in 1991 except for Antelope and Rochelle Mines. Planned capacities for these mines in 1991 are 8.0 mt (Antelope) and 6.0 mt (Rochelle) but capacities at full operation will be higher. Full capacities shown here for the Antelope and Rochelle mines are taken from Coal Age (1981) and Western Coal Planning Assistance Project (1979) respectively. Note also that OTA's analysis of the Powder River Basin (Chapter 6 An Assessment of the Development Potential and Production Prospects of Federal Coal Leases (Washington DC: OTA 1981) uses the lower capacity figures.

3/ Lake DeSmet was rated as having favorable development potential and East Wyodak as uncertain development potential, but both have unfavorable production prospects for 1991. Capacity estimates by OTA.

4/ All three PRLA'S have uncertain development prospects due to possible impediments to lease issuance and, if issued, uncertain production prospects in 1994. Capacity estimates by OTA.

5/ Capacities of proposed mines that are not associated with existing Federal lease from various sources (primarily Coal Age, 1981, DOE, 1979 and DOE 1981) total about 67 million tons. However, closer evaluation of these mine proposals indicates that about 40 million tons of this capacity depends on new leasing of Federal coal and that in several other instances listed capacities exceed the sustainable levels of production when the mine reserves are considered. Mines listed here are only those mines and potential levels of production that could reasonably be expected to occur without new leasing of Federal coal. Capacities listed here were developed in consultation with Gary Glass, Wyoming Geological Survey, Laramie (telephone conversation, May 18, 1981).

6/ Production is contingent on on-site development for power generation and/or synthetic fuels.

7/ Produced in 1980.

8/ Development at this site unlikely because of problems with alluvial valley floors, but reserves may qualify for exchange for unleased Federal coal under provisions in the Surface Mining Control and Reclamation Act of 1977.

Sources: Coal Age (1981) "New Coal Mine Development and Expansion Survey 1980-1989" Coal Age February 1981.

Department of Energy (1979) Western Coal Development Monitoring System: A Survey of Coal Mining Capacity in the West DOE/TIC-10249 (Washington DC: DOE, April 1979).

DOE (1981) Western Coal Survey: A Survey of Coal Mining Capacity in the West, DOE/RA-0045/1 (Washington, DC: DOE, January 1981).

Western Coal Planning Assistance Project (1979) Fact Book for Western Coal/Energy Development
Prepared for Missouri River Basin Commission (Billings, MT: Mountain West Research Inc.)

TABLE 6.8

Planned and Potential Mine Capacities in the Montana Powder River Basin:
199 and Beyond

Developed Federal Mines 1/ Mine Name	Mty	Undeveloped Federal Leases 1/ Uncertain Production Prospects, 1991 Mine Name	Mty	Undeveloped Federal Leases Unfavorable Production Prospects, 1991 Mine Name	Mty	Indian Mines 3/ Mine Name	Mty	Other Nonfederal Mines 4/ Mine Name	Mty
Rosebud	19.8	CX Ranch (Consol)	8.0	Pearl 2/	2.0	Absaloka 6/ (Tract III)	15.0	Montco	12.0
Big Sky	4.6	Squirrel Creek (PKS CX Ranch)	4.0			Absaloka (Tract II)	10.0	Tongue River II	10.0
Spring Creek	10.0					Youngs Creek	8.0	Tongue River III	10.0
West Decker	10.4					Tanner Creek	24.0	Coal Creek 6/	0.2
East Decker	7.6							Dominy 5/	8.0
								Bull Mountain 7/	2.0
								Brophy #2 6/ 7/	0.2
								Bear Tooth 7/	2.0
	52.4		12.0		2.0		57.0		44.4

TABLE 6.8 (Cont)

Planned and Potential Mine Capacities in the Montana Powder River Basin:
1991 and Beyond

Footnotes:

1/ Capacities planned by lessees in 1991.

2/ High strip ratios and non-contiguous reserves give this lease unfavorable production prospects in 1991, but Shell has developed a mine plan and wants to keep options open for possible development at a later date. Undeveloped leases with unfavorable development potential not listed here.

3/ Shell's Youngs Creek mine is planned to start production before 1990. Westmoreland's Tract II Absaloka lease calls for production to begin before 1990, but specific mining plans have not been developed for the tract. Shell has an option to lease reserves in the Tanner Creek area on the Crow reservation, provided Shell can find a market for the coal.

4/ Development of the Montco and Tongue River mines is contingent on construction of the Tongue River Railroad. All these mines could also be affected by the Tongue River unsuitability petition. A larger list of non-Federal mine capacities (i.e., mine proposals not associated with existing Federal mine leases) compiled from various sources (see sources for Table 6.6 and Table A.3.1, Volume II Wyoming Task Force Report), total about 84.4 million tons, excluding the Fort Union region. Consultation with Tom Coefield, Montana Department of State Lands, Helena (telephone conversation May 18, 1981) and Tom Ebzery, Attorney for Tongue River Railroad, Billings (telephone conversation May 19, 1981) indicated that about 40 million tons of this capacity depended on new leasing of Federal coal and are not included in this table. It should be noted that development of optimal mine plans for some of the mines listed here might require acquisition of unleased Federal coal, but such coal is not essential to mine development.

5/ Production contingent on on-site development for synthetic fuels.

6/ Non-Federal mines that produced coal in 1980.

7/ These mines are in central and western Montana but are included here because DOE includes production from these areas with the Powder River Basin for setting of production goals.

TABLE 6.9

Summary of Potential Mine Capacities in Powder River Basin, 1991 and Beyond,
With Comparison to "Likely" High Demand in 1990 and 1995

	Wyoming (mty)			Montana (mty)			Whole Powder River Basin (mty)			"Likely" High Demand***	
	Export*	On-Site**	Total	Export*	On-Site**	Total	Export*	On-Site**	Total	1990	1995
Capacity likely by 1991											
Developed and Undeveloped Leases	248.7	13.8	262.5	64.4	-	64.4	313.1	13.8	326.9		
Currently Producing Non-Federal Mines	8.0	-	8.0	15.4	-	15.4	23.4	-	23.4		
Subtotal	256.7	13.8	270.5	79.8		79.8	336.5	13.8	350.3	225	306-383
Possible Additional Capacity By or After 1991											
Federal Leases and PRLA'S	-	46.5	46.5	2.0	-	2.0	2.0	46.5	48.5		
Indian Mines	-	-		42.0	-	42.0	42.0	-	42.0		
Other Non-Federal Mines	3.0	11.0	14.0	36.0	8.0	44.0	39.0	19.0	58.0		
Subtotal	3.0	57.5	60.5	80.0	8.0	88.0	83.0	65.5	148.5		
GRAND TOTAL	259.7	71.3	331.0	159.8	8.0	167.8	419.5	79.3	498.8	225	306-383

Footnotes:

* Reserves suitable for export from region and/or on-site development.

** Production Contingent on on-site development for power generation or synthetic fuels.

*** DOE medium coal production goals from Department of Energy, Preliminary National and Regional Coal Production Goals for 1985, 1990 and 1995 (Washington DC: DOE August 7, 1980). Lower number for 1995 is ICF's mid-level projection (ICF, 1980b).

Source: Derived from Tables 6.6 and 6.7.

coal from the region. Consequently, actual mining capacity may be less than 350 million tons in 1991, but this would be because of demand factors and not the inability of mines to attain higher levels of production. Potential production levels (as distinct from mine capacity) is probably somewhat lower than 350 million tons because factors such as equipment breakdown and maintenance and transportation availability may limit production below capacities.*

The potential exists for additions of as much as 150 million tons capacity in the Powder River Basin by 1991 or after, of which 65.5 million tons (44%) would depend on on-site development (see Table 6.9). This potential capacity excludes mine proposals that depend on new leasing of federal coal, or do not have reserves sufficient to sustain production levels for more than ten years. There is a lower level of certainty concerning the likelihood for production (or economic viability) of this 150 million tons, but it represents a likely upper limit for additional capacity in the Powder River Basin without leasing of new Federal coal. Even if only half of this capacity is developed, potential capacity in the Powder River Basin would be 425 million tons (and if all the capacity was developed, capacity would be almost 500 million tons), which exceeds the DOE 1995 projection of 383 million tons by over 40 million tons and the ICF projection by 120 million tons. It could well be that these capacities would be sufficient to meet demand to the year 2000.

*In some of the largest mines in the Powder River Basin it may be difficult to sustain peak capacity because of the number of pits that must be in operation. One source considers 20 million tons/year to be the practical limit to sustained production from a single mine in the Powder River Basin (phone conversation with Tom Ebzery, Attorney for Tongue River Railroad, Billings, MT, May 18, 1981). If this is the case, peak capacity should be reduced by about 13 million tons since the Rawhide, Eagle Butte and Cordero Mines all have planned capacities in excess of 20 million tons (see Table 6.7).

Table 6.10 summarizes potential mine capacities in southern Wyoming. One significant difference between this area and the Powder River Basin is that potential production from non-federal mines is minimal because a checkerboard coal ownership pattern predominates in the region. Capacity likely from existing leases by 1991 is very near the likely high demand in 1990, with possible additions of 13.5 million tons of which 6.0 million tons capacity depends on on-site development and 4.5 million tons is the result of production maintenance leasing.

In summary, potential capacity from existing federal leases and proposed non-federal mines in the Powder River Basin is probably sufficient to meet likely levels of demand through to 1995 and possible through to the year 2000. In southern Wyoming, potential capacities are sufficient to meet likely demand through to the early 1990's, but if the high likely level of demand develops in 1990 (51 million tons), production from mines that depend on new leasing of federal coal might be needed to meet further increases in demand in the mid-1990's.

TABLE 6.10

Planned and Potential Mine Capacities in Southern Wyoming: 1991 and Beyond

Developed Federal Mines 1991 Capacity		Undeveloped Federal Leases Favorable Production Prospects 1991		Undeveloped Federal Leases Uncertain Production Prospects 1991		Preference Right Lease Applications		Non-Federal Mines	
Mine Name	mty	Name	mty	Name	mty	Name	mty	Name	mty
Medicine Bow	3.3	Hanna South	0.6	Cherokee 4/	6.0	Bean Springs 5/	1.0	Corral Canyon 6/	2.0
Rosebud	3.4	South Haystack	3.0					Leucite Hills 7/	0.5
Seminoe No. 1	- 1/	Long Canyon	2.0						
Seminoe No. 2	- 1/	North Block	1.5						
Vanguard No. 2	1.0	Twin Creek	2.5						
Canyon No. 1	1.5	Carbon Basin 3/	4.5						
Black Butte	10.0								
Jim Bridger	7.9								
Stansbury	1.3 2/								
Elkol-Sorenson	5.0								
Skull Point	1.5								
	34.9		14.1		6.0		1.0		2.5

Capacity Likely by 1991 49.5 8/
Possible Additional Capacity 13.5 9/
By or After 1991 63.0

Likely Range of Demand 1990: 42-51 10/

Source: Tables 5.5 and 6.3

TABLE 6.10 (Cont)

Planned and Potential Mine Capacities in Southern Wyoming: 1990 and Beyond

Footnotes:

1/ Reserves will run out by 1991.

2/ Mine shut down in late 1980, but is expected to reopen by 1986.

3/ Pending Federal lease not analyzed in this report.

4/ Production contingent on on-site development.

5/ Post 1990 production uncertain due to distance from rail lines.

6/ New Federal leasing is desirable, but not essential to opening this mine and Rocky Mountain Energy is proceeding with plans to develop the mine even though the area is not proposed for new leasing in the upcoming lease sales (personal communication, Stephen Berg-Hansen, Manager of Policy Analysis and Government Affairs, Rocky Mountain Energy, Denver, Colo. October, 1980).

7/ Reserves not sufficient to sustain production much past 1990.

8/ Planned capacity from first two columns of this table plus 0.5 for Leucite Hills.

9/ Cherokee and Corral Canyon, plus capacities from Rosebud (1.0 mty), Seminoe No. 1 (3.5 mty) lease tracts which were in the January 1981 lease sale.

10/ Wyoming Task Force projection, see Table 5.3.

CHAPTER 7. IMPLICATIONS FOR NEW LEASING

When examining the question of whether there should be new leasing of federal coal, a clear distinction must be drawn between specific situations where new leasing may be appropriate on a small and limited scale (as has been done since the 1971 "moratorium" on leasing) and the need for leasing new blocks of federal coal which would allow large new mines to open. The major controversy centers on the need for large-scale leasing of new federal coal, but a few words will be said here about the conditions in which small-scale leasing is appropriate.

Small Scale Leasing

There are several situations where small scale leasing of federal coal is appropriate: 1) windows and bypass situations, 2) production maintenance, and 3) leasing for experimental mines. While there may be some dispute between environmentalists and industry over the appropriateness of such leasing in specific situations, there is not dispute that there are places where such leasing of federal coal is appropriate.

Where existing mines contain small windows or adjacent parcels of unleased coal that would not be economical to mine if they are bypassed, it is desirable to lease these small amounts of federal coal to promote efficient recovery of reserves. As a general rule, the incremental environmental impacts of continuing an existing mining operation are much less than those resulting from opening an entirely new operation, so where there is a choice between continuing an existing operation or opening a new mine, it is usually preferable on environmental grounds to continue in the area where disturbance has already occurred. Where mines

are located in areas of high environmental values and mining has not caused irreversible damage, this may not be the case. In southern Wyoming, at least three mines are located where additional leasing in the near future can probably be justified on this basis: Medicine Bow, Rosebud and Seminoe #2. Areas adjacent to these mines are all scheduled for the first lease sale under the new federal coal management program in early 1981. In this situation it doesn't matter whether the new federal coal is leased by the mine operator or a new lessee, since the incremental environmental impacts stay essentially the same.

OTA has concluded that in general the quality characteristics of available leased federal coal and non-federal coal place no serious constraints on the ability of coal producers to meet the quality needs of particular coal users.* Consequently, there is no real justification for large-scale leasing of federal coal to meet special coal quality needs as has been suggested by some industry spokesmen. However, there are situations where leasing of federal coal which requires special mining techniques might be desirable to promote development of new mining technologies. Two examples where such leasing might be appropriate are a lease that was proposed in the Ham's Fork Region in Wyoming to develop methods for underground mining of steeply dipping coal seams** and the

*See Chapter 3 (OTA, 1981). It should be noted that specific leaseholders may not control the quality of coal they would prefer (i.e., they control non-federal coal that they want to mine because of its high quality but cannot do so without new leasing of federal coal), but this is a problem for that individual coal producer, and does not limit the availability of coal of suitable quality to coal users.

**This lease was proposed in the negotiations for settlement of the NRDC v. Hughes litigation, but was not included in the final agreement because the large size of the proposed lease did not seem consistent with a size appropriate for developing experimental methods.

request by ARCO Coal Company that the Department of the Interior lease a tract suitable for in-situ gasification in the Powder River Basin.*

As has already been mentioned, the principle of small scale new leasing in the above discussed situations is not disputed. During the coal leasing moratorium, roughly 75 million tons of recoverable reserves were leased to avoid bypass or to maintain production. During the first 10 months of the new Federal Coal Management Program, 154 million additional tons were leased for similar reasons. In some situations, new leasing may not be necessary at all, since current regulations (43 CFR Subpart 3432) allow the addition of up to 160 acres to an existing lease through lease modification. The mechanism to allow small scale leasing existed before the new Federal Coal Management Program was established, and thus the situations described above are not major issues in the debate over the need for new leasing.

Large Scale Leasing

Proponents of a full-scale leasing progam in the near future cite two basic reasons for their position: (1) need for expanded leasing to accommodate the contingencies of increased demand, shortfalls in supply and the long lead times needed to commence production, and (2) the need for additional and timely leasing to ensure competition among the

*As discussed in Chapter 2, the Powder River Basin is probably not the best place to promote development of in-situ gasification. Furthermore, there are several existing leases on which reserves are suitable only for in-situ gasification, but leaseholders are not actively trying to develop this technology. Nevertheless, it might be appropriate to make a small tract available for lease that is suitable only for in-situ gasification, given the fact that ARCO has expressed willingness to invest its own money into such a project.

producers. Another reason given is that even if there is no immediate need for new leasing, there is no harm in overleasing, since production will only occur on those leases for which there is demand for coal. Those who argue against the need for rapid start-up of large-scale leasing give three main reasons for not doing so: (1) the potential capacity of existing leases, preference right lease applications and non-federal mines in the west far exceeds the likely range of demand for coal during the next ten years (and possibly 15 to 20 years in some regions), thus there is already an ample safety factor in terms of contingencies for fluctuations in demand; (2) this potential capacity ensures that coal markets will be fully competitive for a considerable time into the future; and (3) leasing significantly in excess over demand is undesirable for a number of economic, environmental and socioeconomic reasons. The two viewpoints summarized above arise out of different answers to the same question, thus the analysis of these issues in this chapter will look at the basic questions that must be answered to determine whether there is a need for significant new leasing before 1985.*

Do Demand Uncertainties and the Need for Long Term Contingency Planning Require New Leasing?

Some proponents of full-scale leasing contend that federal coal leasing should be geared to meet the maximum demand for coal that could possibly occur from a given region within a 20-year planning horizon.

*Even those who oppose new leasing recognize that eventually new leasing will be needed. The dispute is over how soon and how much. 1985 has been rather arbitrarily chosen as a year to separate those who want new leasing quickly and those who feel new leasing should be delayed. For those who feel leasing should be delayed, most would probably agree that 1985 is the earliest that serious consideration should be given to resumption of significant new leasing.

This position rests on three arguments: (1) because future demand projections are speculative at best, sufficient margins for error must be allowed to ensure tht leasing does not limit the maximum possible demand in the long term; (2) it normally requires ten years to obtain a lease, plan, obtain permits and begin production of federal coal, thus planning and leasing targets must be based on a 20-year strategic planning horizon; (3) if for unforseen reasons, e.g., financial problems, labor problems or material shortages, present undeveloped leases were not able to produce the forecast tonnages in the 1990's shortfalls in supply could occur.

There are four reasons why these arguments do not justify the resumption of significant new leasing before 1985: (1) potential capacity of 350 to 500 milliion tons in the Powder River Basin is so far in excess of any reasonable expectations of demand (OTA considered a 1990 demand range to 200 to 226 million tons to be most likely and 275 million tons to be an upper limit) that a margin of safety exists and is exceeded for the next 10 to 15 years at least; (2) the estimate of ten years needed to obtain a lease, plan, obtain permits and begin production of federal coal is probably exaggerated and even if true, this time period is certain to be reduced in the future; (3) unforeseen reasons (financial and labor problems, or material shortage) that might prevent production on undeveloped leases would equally affect (and probably more seriously affect) new leases, consequently this argument is irrelevant to the issue; (4) even if shortfall should occur (which is highly unlikely in all regions in the west except perhaps southern Wyoming) demand could easily be met by increases in production from other coal regions without serious economic consequences.

Demand Uncertainties and Margins for Error Demand uncertainties must certainly be taken into account when considering the need for new leasing. Levels of uncertainty in demand projections can be reduced by examining a variety of projections for the same year based on production and computer model projections from several sources. By doing this, it is possible to develop a likely range of demand and eliminate projections that are based on extreme assumptions (the rationale for this approach is discussed further in Chapter 4, OTA, 1981). It must also be kept in mind that the uncertainty of demand projections lessens as the year for which a projection is made approaches. You do not have to wait until 1990 to determine that a projection made in 1980 was in error. For example, the most likely range of demand identified by OTA for 1990 is based on a number of assumptions concerning electrical growth rate, transportation costs, export demand, etc. If in 1982 or 1983 the actual electrical growth rate, transportation costs, etc., differ significantly from those used to bracket low and high ranges of likely demand, then the likely range of demand can be modified accordingly. Thus, as the time period approaches, confidence level in the likely range of demand increases.* It should be possible to anticipate pending possible shortfalls between demand and potential production six or seven years in advance, and respond accordingly (see later discussion of lead time).

When a range of likely low to likely high demand has been identified, it means that a certain safety margin has been built into the

*It is important that this likely range of demand continue to be based on evaluation of projections from a number of different sources. Modifying parameters for a single computer model to develop new projections would not have as high a confidence level as modification in the manner described above.

demand projections. It is a philosophical judgment more than anything else as to how high the margin of safety should be. There are two reasons why a modest, rather than a large, margin of safety is preferable: (1) a large margin of error as a basis for making leasing decisions is more likely to create environmental and socioeconomic problems than a smaller margin (see later discussion of overleasing), and (2) even if there are shortfalls in production from a region because the margin of safety is too small, such shortfalls could be met by production from other regions without serious economic consequences (see later discussion of shortfalls in leasing). In such an event, shortfalls should be slight since a margin of safety has already been factored int.

Strategic Planning Horizon The coal industry estimates that it requires a decade to bring federal coal into production: two years for leasing and planning; five to seven years for permitting and development of transportation and base facilities, and three years start-up before full-scale production is reached. If this is true, then the planning horizon for new leasing would need to exceed ten years, although a 15 year planning horizon, rather than the 20 suggested by industry would probably be adequate. As has been discussed previously, in the Powder River Basin potential capacity without new leasing is adequate for the next 15 and possibly 20 years, but as a general principle the strategic planning horizon needs to be clearly defined. The coal industry has provided little convincing document for its contention that a full 10 years will be needed from lease issuance to full-scale production. While there is no question tht it takes longer to open a mine under the current regulatory framework compared to mine development in the early 1960's, there are a number of reasons why ten years is an overly pessimistic

estimate of typical lead-times: (1) many of the difficulties being experienced by companies now in the permit process can be attributed to the lack of familiarity by both coal operators and regulatory authorities wih the requirements of SMCRA. It is unlikely that more stringent environmental permit requirements will be developed (and with the current administration it appears likely that they will be simplified), thus current experience represents a worst case situation, and time periods can be expected to shorten as experience is gained by both coal operators and regulatory authorities and guidelines and procedures become established; (2) many delays experienced by companies can be attributed to poor planning on the part of the company due to an unwillingness to take environmental requirements seriously; and (3) the coal industry tends to confuse leadtimes for mine development that are related to market demand with procedural leadtimes (which are lead times required to open a mine under strong market demand).

Procedural leadtimes under conditions of strong market demand will probably be closer to the six years estimated by the Department of the Interior than the 10 years estimated by industry. For example, at the Big Sky Mine in Montana, a little over two years lapsed between the time Peabody Coal Company signed a lease with Burlington Northern Railroad in 1966 and when production started on the lease (Jones and Beckner, 1974). When Peabody signed its first federal lease at Big Sky in 1971 it took a little more than three years to obtain approval of its mine plan, and Jones and Beckner (1974) concluded that under normal situations approximately three years were required to complete environmental studies and obtain permit approval. The more complex permitting requirements of SMCRA might add some time to this estimate, but this estimate appears to

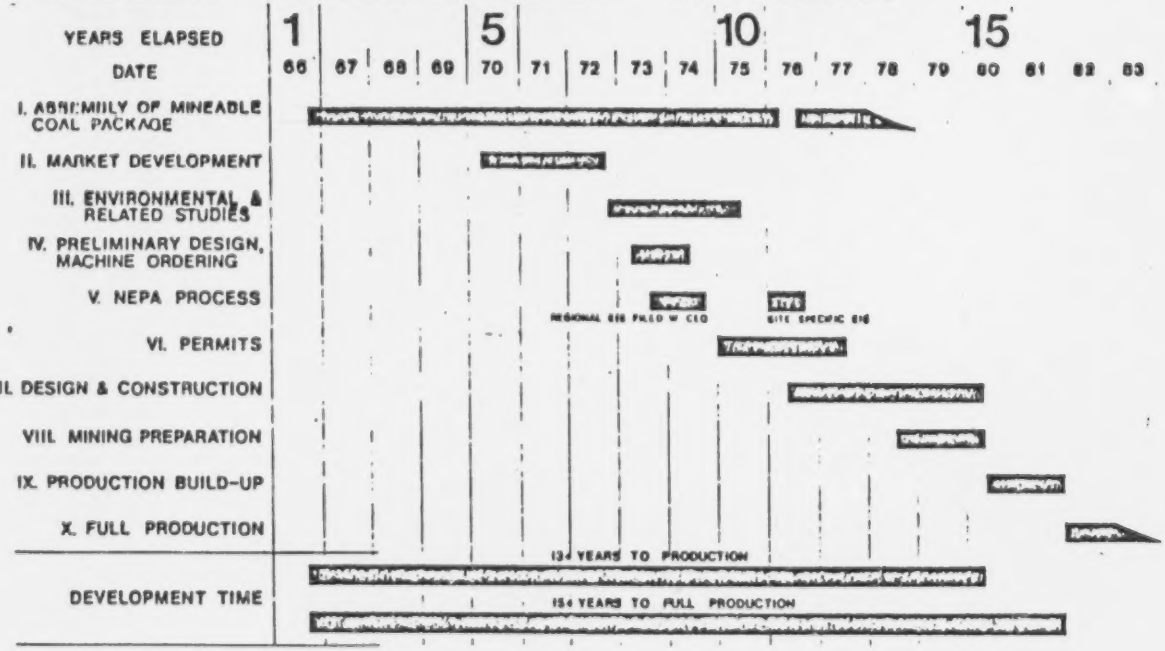
be more consistent with a total time period of six years than of 10 years from lease to production.

Peabody Coal Company's Rochelle lease in Campbell County, Wyoming is an example of the confusion between a market-related leadtime and a procedural leadtime. Grandt (1978) uses the Rochelle lease as a case study to demonstrate the long leadtime needed to develop a federal lease. Figure 7-1 illustrates the development schedule for this lease and indicates that seven years were necessary for environmental requirements, permitting and mine preparation. According to this Figure, production was supposed to begin in 1980. OTA's assessment of the Rochelle lease indicates that production may well not begin until 1990, ten years later, but the reason is lack of markets for the lease, not environmental and permitting procedures.

The major reasons for long leadtimes for lease development at the present time are 1) lack of markets, and 2) lack of experience with the new regulatory framework created by SMCRA. During the next five years the length of time required to obtain permit approval should decline, and also the new Federal Coal Management Program should be functioning more smoothly. Consequently, it is not unreasonable to expect that by 1985 leadtimes from lease issuance to production should probably allow development of new leases by the early 1990's, if this should be necessary.

It is preferable to have the federal coal leasing program be able to respond to changes in the demand for coal in short rather than long planning horizons. Once the new federal leasing program and implementation of state programs under SMCRA are functioning smoothly (which is not the case now) a 10 year planning horizon should be attainable (i.e.,

Figure 7.1 **Illustrative Surface Mine Development Schedule (Federal Coal - Rochelle)**



Source: Grandt (1978).

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the system can respond to changes in the demand for coal that can be anticipated 10 years or less in the future rather than 20 years in the future). Even if lead times should not decline to this level by 1985, there is still sufficient potential capacity from existing leases that shortfalls would be unlikely with new leasing in 1985 even with longer lead times.

Possible Shortfalls in Production A major concern is expressed by industry about possible shortfalls in production if new leasing is not initiated soon in the west. OTA's analysis of the development and production potential of existing federal leases in the west (OTA, 1981) indicates that there is no serious likelihood of shortfalls until possibly the mid-1990's (i.e., in most regions potential capacity exceeds likely high demand in 1990 by a large margin). The one exception to this may be southern Wyoming, where the likely high demand for coal is very close to the potential capacity in 1990 (i.e., the safety margin--likely high demand--has little additional margin for error). Nevertheless, even if there were no further leasing of federal coal* and shortfalls of production below demand developed, there would be not serious difficulties created either in terms of the availability of coal or in the cost to consumers. In this specific situation the "shortfall" of production would be met by slightly increased production in another region in the west or in the midwest. Shortfalls of coal production only become a serious problem when a number of regions do not have the capacity to respond to demand, causing production to shift rapidly to more marginal and costly coal deposits (ICF, 1980b).

*The first lease sale under the new Federal Coal Management Program was held in the Green River-Hams Fork Region in January, 1981. These leases will push potential capacity well above the likely high demand in 1990. These leases in southern Wyoming are really production maintenance leases, and were probably justified for reasons discussed under small-scale leasing.

The potential capacity in all the other major federal coal regions in the west is such that limited production in southern Wyoming would not create serious problems in coal production. This is an important point because in the haste to lease new federal coal in southern Wyoming, most of the tracts that have been delineated that involve opening of new mines are in areas where there is considerable concern over disturbance of critical wildlife habitat (see discussion of this in Chapter 3). Thus, there are good environmental reasons to not continue leasing according to the schedule that is currently being followed, even though this is the only region in the west where potential capacity does not exceed the likely high demand in 1990 by a large margin.

Is New Leasing Needed to Increase Competition in the Coal Industry?

The Department of Justice (1980) and the General Accounting Office (1980) have criticized the setting of leasing targets in the new federal coal management program as being inefficient and potentially anticompetitive. This criticism is based on the assumption that leasing targets do not adequately take into account uncertainties in demand and thus may cause shortfalls in production which then would reduce competition. In fact, the very production goals that have been criticized by DOJ and GAO as not having a sufficient margin of error are considered by OTA to be far in excess of the likely range of demand for the Powder River Basin.

Although there is some concern that coal production in this country is becoming increasingly controlled by the energy majors, all recent studies to date indicate that the coal industry is highly competitive (DOE, 1981). In fact, it might be argued that the tremendous excess in potential capacity in the Powder River Basin could ultimately lead to

decreased competition in the region. This is because the big companies can afford to take short-term leases in the cut-throat competition that is likely to exist during the next ten years, while leaseholders with more limited resources could go bankrupt because of inability to make a profit in such a competitive situation.

A report by the Department of Energy (1981) has noted that in regions such as the Powder River Basin where future mining will depend heavily on the availability of federal coal, severe limitations in the availability of federal coal for lease could create an artificially high barrier to entry for new firms, as well as shift substantial market power to present industry participants. This is true only if easy entry by new firms is necessary to have a disciplining effect on prices and output. This is clearly not the case in the Powder River Basin where limited demand will have the major disciplining effect on prices for the next 15 years or more. While it is unfortunate that past leasing practices have rewarded existing leaseholders by limiting the need for entry of new firms, this does not provide a justification for new leasing since such entry is not needed to increase competition.

The competition argument also assumes that there is no harm in over-leasing. As discussed in the next section, there are problems with overleasing, thus the significance of promoting competition by the leasing of federal coal must be framed in the context of how big a safety factor is necessary to prevent possible anti-competitive effects if actual demand exceeds anticipated demand. As discussed previously, this does not appear to be a significant problem in the west for the next 15 years or so.

Is Overleasing Undesirable?

From a purely industry perspective, there is nothing wrong with overleasing: those leases that are not needed to meet demand will not come into production. However, the environmental side of the mining Task Force of the National Coal Policy Project has outlined a number of reasons why, as matter of public policy, it is undesirable to overlease federal coal (i.e., to lease new federal coal far in excess of likely demand):*

1. Royalty rates on existing leases are far below rates that obtain under current market conditions, consequently, financial return to the public for federal coal that is currently being mined is less than it would have been if leases had been let under current market conditions. Overleasing in the future may have the same result.

2. Overleasing may drive down revenues to private, state, and Indian lessors and, to the extent that overleasing reduces the cost of coal below what it would be if the Federal government did not control the majority of western coal reserves, may distort the cost of electricity.

3. Overleasing may encourage marketing of western coal in areas served more properly by closer coal fields, particularly in states where automatic fuel adjustment clauses allow utilities

*National Coal Policy Project (in press) Land Use Planning and Market Forces in Federal Coal Management (Washington, D.C.: Center For Strategic and International Studies). Note that this material represents the position of the environmental side of the Task Force only.

to purchase coal from captive mines at costs higher than the cost of coal from closer coal fields.

4. Overleasing makes planning difficult for local communities because it is more difficult to anticipate the level of development that will occur. Similarly, the existence of leases that are not mined due to overleasing distorts the planning process and makes it more difficult for surface management agencies to apply effectively the principles of multiple-use/sustained yield.

5. The environmental and social costs of mining coal in the west are currently not being adequately internalized into the price of western coal, and overleasing, with the accompanying pressures in favor of mining once an area has been leased, may encourage even less attention to internalizing these costs. To the extent that this may displace coal production to the west from other coal regions where environmental and social impacts are less adverse, or displace production from suitable non-federal coal in the west, overleasing of federal coal is undesirable.

Summary and Conclusions

There is no clear need for significant new leasing of federal coal before 1985 for the following two major reasons: (1) the potential production capacity from existing federal coal leases and non-federal mining in the west is more than sufficient to meet the highest reasonable levels of demand that can be expected in the early 1990's and also to

maintain a competitive coal industry, and (2) the further leasing of federal coal in excess of likely demand is undesirable because of possible adverse effects on regional and local land use planning in the west and for environmental reasons. Some more specific reasons to delay new leasing in the Powder River Basin and southern Wyoming until 1985 (and possibly later for the Powder River Basin) include:

1. The current leasing schedule for southern Wyoming and the Powder River Basin has provided little time to gain experience in implementing the new federal coal management regulations, and to bring land use plans into conformance with current land use planning regulations under FLPMA. By 1984 Resource Management Plans should be fully updated, and time would be available for more extensive tract delineation.

2. By 1984 all preference right lease applications will be either issued or denied, allowing planning for new leasing to be conducted without uncertainties imposed by outstanding PRLAs.

3. By 1985 uncertainties concerning diligence requirements on existing leases should be near resolution. If diligence requirements can be legally enforced, the leases likely to qualify for extensions, as well as those subject to cancellation, should be clear. If diligence requirements cannot be legally enforced, a reevaluation of production prospects from existing leases could be taken into consideration in leasing decisions.

4. More time in the planning and tract delineation process would allow establishment of well defined criteria for identifying alluvial valley floors. This would allow elimination of alluvial valley floors where mining is not desirable during tract delineation rather than after leasing is done, something that industry and environmental participants in the Wyoming Task Force agreed is desirable. Also, by 1985, experience in applying the SMCRA regulations to existing leases with alluvial valley floors should provide some indication as to whether alluvial valley floors that are not significant to agriculture can be mined in an acceptable manner.

5. By 1985 likely demand for coal based synthetic fuel plants should be less uncertain. Also, the effects of the 1979 NSPS, rail deregulation, and the electrical growth rate on demand for coal from the Powder River Basin and southern Wyoming will be clearer than they are now.

It should be emphasized that the conclusion that there is no need for large-scale leasing of federal coal before 1985 does not mean that preparations for new leasing should be stopped. To the contrary, if the new Federal Coal Management Program is to function effectively it is imperative that updating of land use plans in coal regions, delineation of potential lease tracts and processing of preference right lease applications receive a high priority, so that when a need for new leasing becomes evident the system will be ready.

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